LIPPINCOTT'S FARM MANUALS

PRODUCTIVE DAIRYING

BY

R. M. WASHBURN, M. S. A.

$8\frac{1}{2}$ lb. = 1 gall.

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"The first farmer was the first man, and all historic nobility rests on possession and use of land."
—EMERSON.

LIPPINCOTT'S FARM MANUALS

EDITED BY
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PRODUCTIVE DAIRYING

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JERSEYS COMING HOME TO BE MILKED

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131 ILLUSTRATIONS IN THE TEXT

"If vain our toil,
We ought to blame the culture, not the soil."
POPE—*Essay on Man*

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PREFACE

This book was written for use in High Schools, Schools of Agriculture, Colleges of Agriculture, general courses, Rural Consolidated Schools and for the many studious young farmers who have been deprived of systematic agricultural education.

From an experience of more than thirty years in dairy work, covering much of the United States, the author has written, without haste, what he feels and knows, from innumerable questions asked, to be what the thoughtful reader desires to know. Many of the finer and more technical points have been omitted. There is enough that is known to furnish a foundation and guide for good practice.

The lists of questions following every chapter will aid the student in fixing in his mind the essentials of the points discussed.

The chapter on common diseases was written by Dr. W. L. Boyd, Assistant Professor of Veterinary Medicine, University of Minnesota, for this book.

Acknowledgment is due and gladly made to the secretaries of the various breed associations, various Experiment Station workers and business firms from whom help has been received and to Professor T. L. Haecker, Dr. Carl W. Gay and Professors H. H. Kildee, W. A. McKerrow, G. W. Gehrand, A. D. Wilson and E. O. Hanson, for assistance rendered in the nature of criticism and suggestions

R. M. Washburn.

University Farm,
St. Paul, Minnesota
February, 1917

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PART I

THE WHY OF DAIRYING

PRODUCTIVE DAIRYING

CHAPTER I

HUMAN FOOD PRODUCTION

The history of Agriculture in civilized nations has been one of change from grain growing with livestock farming of a mediocre sort as a mere incident, to definite livestock farming with better animals; stock was chiefly of beef characteristics; and from this grew a yet more intense cultivation of the fields which are kept up in fertility largely by dairy cows. The best dairy districts of Europe were once beef and grain-growing centers and our own eastern states fifty years ago were noted beef centers but are now systematically and intensively in the business of producing milk.

The West that once boasted of its large herds of cattle is now cut up into farms of moderate size where many dairy-bred cows are kept and many others are used in a dairy way. It is evident that the United States will either be a nation of balanced dairy farms within a few decades or be an exception to the rule.

The question may very properly be asked, Why this direction of affairs? What is there inherent in the dairy type of animal industry that adapts itself to our more intensive conditions? In this chapter, very briefly indeed, the chief reasons are set forth.

The cow as a converter or transformer of coarse, rough feeds into fine grained and more valuable forms has no equal. Physically speaking, the sun is our great original source of warmth and energy. A small portion of the heat which is poured so lavishly upon the earth each summer is captured by the growing plants and stored, some as grain, a little as root crops, but much more in such forms as grass and fodder. Only about forty per cent of the solar energy captured by our cultivated crops is in a form sufficiently fine to be used by man direct, for

example, as corn and potatoes, while the remaining sixty per cent of the energy is in the stalk, leaf, cob, and straw. If we add to this amount the meadow hay and permanent pastures, it seems highly probable that fully seventy-five per cent of the food energy captured in this country, each growing season, is in such form that it is practically useless as food to man until converted by some animal into the form of flesh, milk, or eggs. Plants get their energy from the sun and their substance from the soil and air, while animals get both substance and energy from plants (or other animals). Man is no exception.

Utilization of Waste Forage.—One important reason why livestock is, and should be, kept on most farms, rather than devoting them exclusively to the growing of grain, potatoes and roots of which man can eat only a part, is because of the power of animals to consume and work over a great quantity of common pasture grass, low land hay, corn stover, and some straw. They consume the coarser by-products formed in the making of human food, for example, bran and shorts, or in the making of some other commercial article. Where linseed oil is made for painting purposes there is left linseed oil meal, and where cottonseed oil is made there is left cottonseed meal. Both are highly nutritious as stock feed. These substances may be fed to produce beef, milk (Fig. 1), mutton, or, to some extent, pork. The hog has wonderful powers of flesh formation, in fact, will produce more flesh for the quantity of feed consumed than any other known animal, but his power to consume coarse stuff is limited. The sheep is a highly valuable animal and should be kept in greater numbers than at present, but its peculiarities prevent it being kept in such numbers as adequately to consume any large portion of the coarse feeds grown on American farms. So, at least for the present and probably for many years to come, the consumption and conversion of the bulk of the coarse feeds of our farms must be done mostly by cattle.

The Cow vs. the Steer.—As a food producer, or, more strictly speaking, energy transformer and conserver, the cow, according to Haecker of Minnesota, returns in her product

twenty-nine per cent of what she consumes, while the flesh-forming animal, the steer, and in all likelihood the fattening cow as well, retains as flesh scarcely fourteen per cent. That is to say, that for every 100 units of digestible feed consumed by the normal cow, 29 will be recovered in the milk and 71 lost in the process of transforming, while for every 100 units fed to a steer but 14 will be returned to man as edible flesh and 86 will be lost.

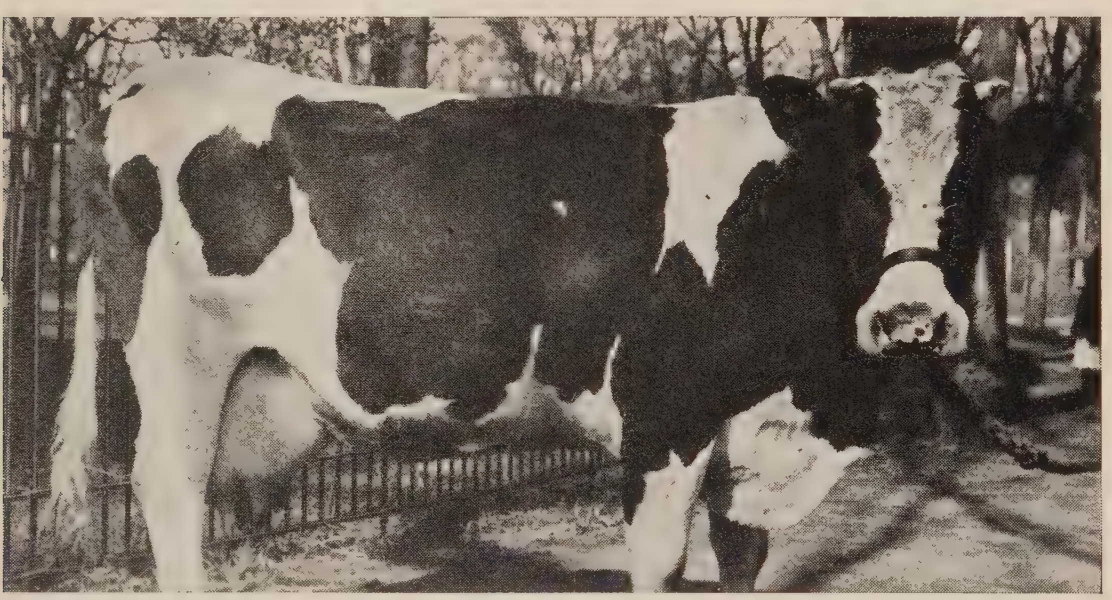

FIG. 1.—Belle—twenty-two and one-half year old Holstein cow still yielding 40 pounds milk per day. She has had twenty-one strong calves. She had strong twins at the age of 21 years. During this period she has produced about 200,000 pounds milk, containing fully 25,000 pounds of solid food. She has been fed on corn silage, clover hay, roots, corn, oats and oil meal. Property Washburn Children's Home, Minneapolis, Minn. Photo by the author.

A cow that yields 6000 pounds of 5 per cent milk in one year will yield 900 pounds of food solids or 2.46 pounds per day, which is as much as can be expected in gross gain, bone, blood, water in tissue, and all, in the steer. A cow that produces 12,000 pounds of milk testing about 3.25 per cent fat and about 12 per cent total solids will produce 1440 pounds of food, or nearly 4.0 pounds per day.

If comparison be made with one of the modern high-producing Holsteins such, for instance, as Lady Oak Fobes De Kol of the Minnesota Station, we find, as pointed out by Professor Haecker, that the 22,063.5 pounds of milk that she yielded in

one year contained the food equivalent of five steers weighing 1100 each, and that every three days she yielded food equivalent to a veal calf weighing 175 pounds. If comparison be made with the product of the noted Guernsey cow, May Rilma (Fig. 2), we find that the food contained in her milk for her best year equalled that in thirty steers weighing 500 pounds each or five steers weighing 1500 pounds each.

The world's champion cow of all breeds in butter production in a year, viz., Duchess Skylark Ormsby, in yielding 27,761.7 pounds of milk, testing 4.34 per cent fat and about 13.25 per cent total solids, produced 3678.4 pounds of solids. Computing

Fig. 2.—May Rilma—the Guernsey cow that produced the food equivalent to five 1500 pound steers in one year. Photo by J. F. Kelley.

this on the basis of the total starch equivalent (fat by 2.25, plus protein, plus carbohydrate) we find that each 100 pounds of milk equalled 18.65 pounds of starch or, better, wheat flour, and that the total "wheat flour" value of the milk solids was 5177.5 pounds or more than 2½ tons. At a yield of 15 bushels of wheat to the acre, more than 8 acres would be required to

produce an equivalent amount of human food in the form of flour. And all this the cow did by working over hay, corn silage and various rough or by-product grains.

From the above brief discussion it will readily be seen why it is that in densely populated sections of the world, where the demand for food is great, and labor cheap, milk production has become of first importance. Dairying is an intensive form of agriculture, requiring more labor, yet recompensing for it if rightly done.

QUESTIONS

1. From what do plants obtain the heat that is stored in them?
2. In what forms do we handle this energy?
3. What per cent of field grain crops is edible by man?
4. How may man eat hay, grass, and silage?
5. How is an animal a transformer of solar energy?
6. Name the domesticated food animals.
7. Which one will return to man the largest percentage of the amount consumed?
8. How many times more efficient as a food producer is a cow than a steer?
9. What is meant by "starch value" of milk?
10. Compare the average cow of your herd with an average yield of wheat or corn.

CHAPTER II

SOIL FERTILITY

As the dairy industry is so closely related to the maintenance of soil fertility, the dairy farmer is bound to consider this as no small element for consideration in the profits from the dairy.

SOIL FERTILITY

Fertilizing Value of Plant and Animal Products.—As is well known, every plant which grows from the ground absorbs and appropriates to itself portions of the soil in which it grew. The quantity and the proportions of the ingredients vary considerably with the nature of the plants. Of the eighty odd chemical elements known, only ten to eleven seem to be absolutely essential to plant life. Of these only three are present in such small amounts, and used in such large amounts as to create a keen necessity that their presence be assured. These three are: nitrogen (measured as nitrogen, N), phosphorus (measured as phosphoric acid, P_2O_5), and potassium (measured as potash, K_2O). Many soils are so lacking in one or more of these essential substances that they must be provided in some artificial way. This condition has brought into existence firms dealing in commercial fertilizers. Immense quantities are regularly sold in this country, especially in the eastern and southern states. The three constituents thus marketed are nitrogen, phosphoric acid and potash, in varying forms and with varying values. Since farm crops all contain more or less of these substances they have a fertilizing value usually measured by their composition and the market price of these three essential constituents. Prices are slowly increasing. Readily available nitrogen is now worth about 20 cents a pound; phosphoric acid and potash each about 5 cents a pound. Below is given a table showing the amount of these three elements contained in 1000

pounds of various plant and animal products. The last column to the right shows the fertilizing value per ton when the above prices are applied.

Fertilizing Constituents in 1000 Pounds of Various Plant and Animal Products

Feeding Stuffs	Nitrogen	Phosphoric Acid	Potash	Fertilizing Value per Ton
	Lbs.	*Lbs.*	*Lbs.*	
Wheat straw	4.3	1.3	7.4	$2.59
Oat straw	6.5	2.2	12.2	4.04
Timothy hay	10.8	3.5	13.4	6.00
Clover hay	20.9	4.3	20.8	10.87
Corn	14.8	6.1	3.7	6.90
Oats	18.1	7.7	5.7	8.58
Wheat	17.3	9.6	3.5	8.23
Rye	16.2	8.1	5.2	7.81
Wheat bran	25.6	29.2	15.7	14.73
Oil meal n. p.	60.0	17.4	13.4	27.08
Cottonseed meal	71.4	30.9	18.2	33.47
Meat scrap	76.3	81.1		38.63
Skim milk	5.0	3.5	2.0	2.55
Whole milk	5.8	1.9	1.7	2.68
Butter	1.2	0.4	0.4	0.56

From this table we learn that every ton of timothy hay sold from the farm removes about $6.00 off the farm, just as truly as though so much soil were shovelled into the river; and that every bushel of wheat sold carries away about 25 cents' worth of the farm. Studying the table more fully we learn that for every dollar's worth of soil fertility sold in wheat there is received in return scarcely $3.50; for every dollar's worth sold in timothy hay from $2.00 to $3.00; for every dollar's worth of fertility in average whole milk at $1.75 per hundred $13.00 are received. While $15.00 are recovered for every one of fertility lost in the sale of beef, the great surprise comes in the matter of butter, where $1071 are received for every one dollar's worth of nitrogen, phosphoric acid and potash sold (butter at 30 cents per pound). This remarkable showing in the case of

butter is due to the fact that it is made almost wholly of the three elements, carbon, hydrogen and oxygen, which are so common as to have no commercial value.

Butter Made of "Wind and Water."—Chemically speaking, butter is made of those same elements which go to form water and the carbon dioxide of air. Having no fertilizing value the sale of butter does not impoverish the soil. Though a highly nutritious food to the consumer, it does not rob the producer. This explains why it is that individual farmers, neighborhoods, or states engaged systematically in the production of butter are, in the long run, prosperous, compared with those who regularly sap their soil to derive their income from the sale of grain or whole milk. Butter may be said to be composed of "wind, water and work."

The value of manure has been known since antiquity. Admonitions to fertilize and cultivate are contained in the earliest writings. Manure has three values: A. Chemical, measured by the amount of nitrogen, phosphoric acid and potash contained in it. These are a direct food to the next crop as would be the same ingredients introduced in other forms. B. Physical. Manure contains fibrous materials which, rotting, yield humus and loosen the soil. This open condition permits water to enter more readily, yet to drain more promptly: also allows air freer access. Aside from the purely chemical aspect manure improves the soil by a change in its physical character. C. Bacterial. Countless billions of bacteria in the manure aid in its decomposition, while rotting acids are liberated which dissolve portions of the soil which had, heretofore, been locked securely in unavailable forms.

Although the bacterial and physical properties are clearly known to have value, they are difficult of determination. Ordinarily, therefore, the fertilizing value of manure is indicated by the amount of the chemical substances carried and figured only one-half as valuable as would be a like amount of the three elements in a form more readily or quickly available.

The amount of manure produced by cattle, horses and other animals varies in amount with the liberality of the feeding, and in chemical constituents with the character of the feeds fed (Fig. 3). The approximate quantities of solid and liquid excrement are shown in the table below.

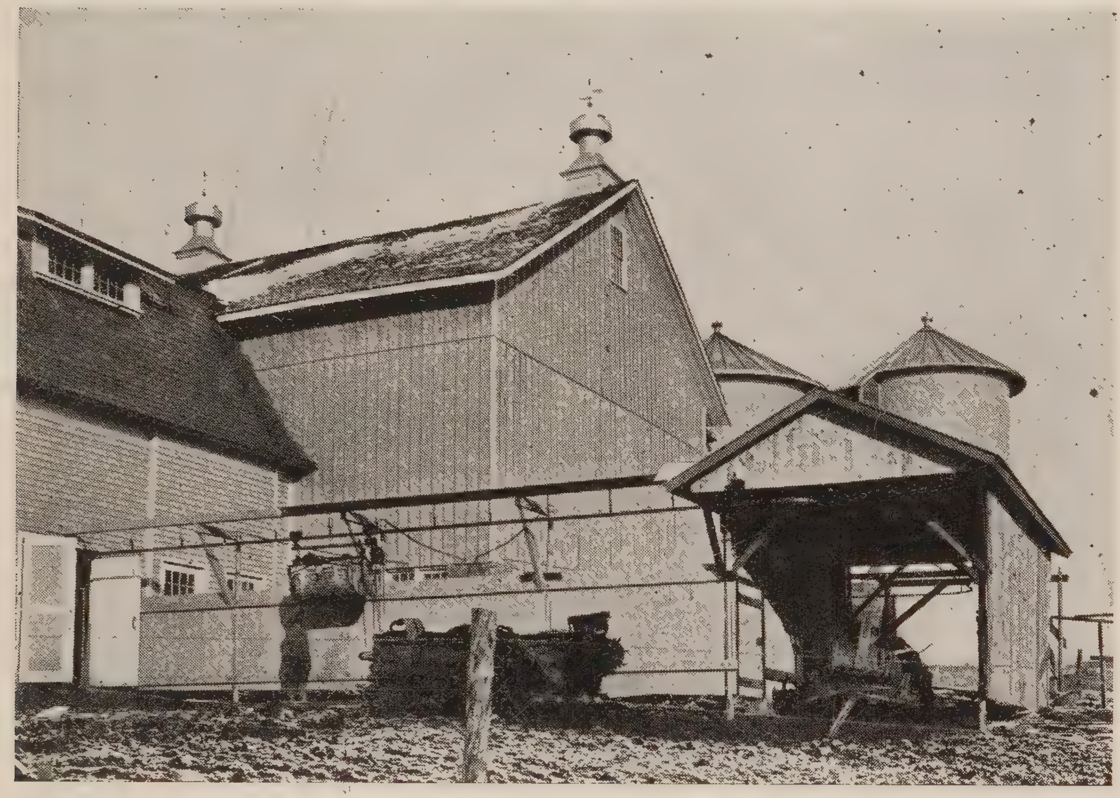

FIG. 3.—Saving labor and fertility on a well-appointed farm. (Photo loaned by James Manufacturing Co., Ft. Atkinson, Wis.)

The Daily Amount and Composition of Liquid and Solid Excrement Voided by Mature Animals [1]

Animal	Solid excrement	Urine	Tota
	Lbs.	*Lbs.*	*Lbs.*
Horses	35.5	8.0	43.5
Cattle	52.0	19.4	71.4
Sheep	2.3	1.5	3.8
Hogs	6.0	3.3	9.3

Though these figures are only roughly approximated they

[1] Ohio Agri. Exp. Sta. Bul. 246, p. 726, 1912.

may serve some useful purpose in estimating the value of the total products derived from animals.

The Composition of Manure.—The amount of nitrogen, phosphoric acid and potash in the voidings of farm animals depends largely on the quantities of these three substances present in the food consumed. The following table indicates as nearly as can be stated the average composition of the solid and liquid voidings of the four principal farm animals:

Fertilizing Constituents in 1000 Pounds of Fresh Excrement of Farm Animals[2]

In Solid Voidings

Animal	Water *Lbs.*	Nitrogen *Lbs.*	Phosphoric Acid *Lbs.*	Alkalies *Lbs.*
Horse	760	4.95	2.99	2.40
Cattle	840	3.24	2.07	1.49
Swine	800	6.0	4.60	4.44
Sheep	580	6.50	4.60	2.28

In Urine

Animal	Water *Lbs.*	Nitrogen *Lbs.*	Phosphoric Acid *Lbs.*	Alkalies *Lbs.*
Horses	890	12.0		14.9
Cattle	920	9.5	.28	9.5
Swine	975	3.0	1.27	10.0
Sheep	865	16.8	3.0	21.1

The alkalies include potash, lime, etc.

The value of manure per ton has been a subject of some discussion and naturally varies with the dryness of the manure (Fig. 4), the feeds previously fed, the degree of decomposition, and of leaching of the manure. A ton of well rotted manure is worth more than a ton of the green stuff, but one and a half to two tons of the green would be required to produce one of the rotted. Based upon the chemical ingredients only, taking the manure in its ordinary condition as removed from stables the following table will indicate fairly closely the value per ton:

[2] Based on Table II.

Value of Manure Per Ton Including Litter[3]

Amount in One Ton

Source of Manure	Nitrogen	Phosphoric Acid	Potash	Value
Horse	13.90	4.97	15.27	$3.78
Cattle	11.40	4.44	12.48	3.12
Sheep	28.78	10.26	24.24	7.48
Hog	10.00	15.34	6.58	3.10

FIG. 4.—Manure should be preserved in a concrete bin where impossible to haul directly to the field.

While the farmers in many sections of this country would hesitate long before they would pay $3.78 per ton for horse-stable manure, the market gardeners about our eastern cities are paying about that amount regularly. So keen is the demand that many full train loads of manure are being regularly shipped out of our eastern cities for sale to farmers at from $2.30 to $2.50 per ton. This price does not include the freight or the cost of hauling and composting on the farm.

The Value of Manure Per Year.—Taking the ordinary rate

[3] Ohio Agri. Exp. Sta. Bul. 246, p. 726, 1912.

of manure production as a basis and the present selling price of the chemical constituents, we have the table as follows:

Weight and Value of Solid and Liquid Excrement and of Nitrogen, Phosphoric Acid and Potash Contained Therein. Per Year Animal.[4]

			Elements contained						
		Excrement	Nitrogen, N		Phosphoric acid P_2O_5		Potash, K_2O		Total value
		pounds	*pounds*	*value*	*pounds*	*value*	*pounds*	*value*	
Horse....	Solid	12,957	64.14	$12.83	38.70	$1.94	31.10	$1.56	$16.33
	Liquid	2,920	35.04	7.01	.....	.....	43.45	2.17	9.18
	Total	15,877	99.18	19.84	38.70	1.94	74.55	3.73	25.51
Cattle....	Solid	18,980	61.50	12.30	39.30	1.97	28.25	1.41	15.68
	Liquid	7,081	67.27	13.45	1.73	0.09	67.13	3.36	16.90
	Total	26,061	128.77	25.75	41.03	2.06	95.38	4.77	32.58
Sheep....	Solid	821	5.34	1.07	3.77	0.19	1.89	.09	1.35
	Liquid	546	9.20	1.84	0.16	0.01	11.57	.58	2.43
	Total	1,367	14.54	2.91	3.93	0.20	13.46	.67	3.78
Hogs.....	Solid	2,190	13.14	2.63	10.07	0.50	9.72	0.49	3.62
	Liquid	1,205	3.62	.72	1.52	0.08	12.00	0.60	1.40
	Total	3,395	16.76	3.35	11.59	0.58	21.72	1.09	5.01

In the last column we learn that the average horse, well fed, will void in a year both liquid and solid manure to the value of above $25.51; that the cow voids about $32.58 worth. These figures seem very high and are much higher than most farmers would be able to recover because much manure is dropped by the roadside or on the hillside pasture and washed away. The urine, so rich in nitrogen, is often largely wasted about the farm. Another loss probably as great as all others is the leaching, and, in the case of the horse manure, heating in piles. If, therefore, only a half or even a third, of the total amount calculated were to be regularly saved the amount still would be an item highly well worth considering, especially when we remember that aside from its chemical, there are the physical and bacterial values.

QUESTIONS

1. What three elements of the soil are most likely to require replacing artificially? What would you consider as the fourth element?
2. What are they worth per pound?
3. What would a ton of clover hay be worth as manure? A ton of timothy?
4. What substance regularly sold from the farm brings in the most money for the soil fertility that is lost?
5. Explain in what sense butter is made of "wind and water."

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[4] Ohio Agri. Exp. Sta. Bul. 246, p. 726, 1912.

6. What three values has manure?
7. How many pounds of manure will a cow make in twenty-four hours?
8. Which one of the three fertilizing elements is most valuable per pound?
9. Which is richer in this element, the solid or the liquid voidings?
10. What is a fair value of cow manure per ton?
11. How many dollars' worth of manure will a cow make in one year? How much may be saved?
12. How may straw be made back into soil to best advantage?
13. Describe ways in which manures are wasted where you have observed them.
14. Tell how manure is best saved for farm use, and give your observations of good methods.

CHAPTER III

REGULATION OF LABOR

Dairy farming has a number of advantages over other types of farming as regards the farm labor problem. In the paragraphs of this chapter are considered the several ways in which dairying is related to the farm labor problem, which is so often a difficult one.

Dairy Products Valuable Per Pound.—Any farmer located some distance from market should consider carefully the value of his commodity when measured in terms of the load to be carried or drawn to town. Thus, while common wild hay is worth from $6 to $10 per ton, wheat or oats from $25 to $30 per ton and cream from $150 to $200 per ton, butter is worth $400 to $600 per ton. There are few, if any, farm crops or products which will return as much per pound as well made butter. In regions of bad roads, the production of well-made dairy butter should be encouraged.

Regular Income.—The regularity and frequency of the income from dairying is an argument in its favor. Current expenses of the home may be paid as contracted so that when the annual sale of field crops or livestock takes place these proceeds are available for the larger items, such as making payment on the farm, buying improved stock or machinery.

Child Labor.—The diversified livestock farm offers the best place in the world for the proper, profitable, employment of children (Fig. 5). The chicks are to be fed, the calves must have their little mess of milk, lambs need assistance, and cows wait to be milked twice a day. Much of this sort of necessary work may be performed by mere children, and that to their advantage. While in calculating the cost of keep of any class of animals the labor element should be included, the fact of the presence of these animals makes it possible for children to be wage earners in their own homes. Thus if the cow be charged

for the labor performed on her the system must be credited with an equal amount, for the money is still in the family available for household uses.

Direct Incomes.—By direct income is meant the proceeds from the sale of the chief product of the dairy. In some sections whole milk is sold for use in cities; in others, butter fat is sold as cream for butter-making purposes, the milk being kept on, or returned to the farm for feeding purposes. At present prices

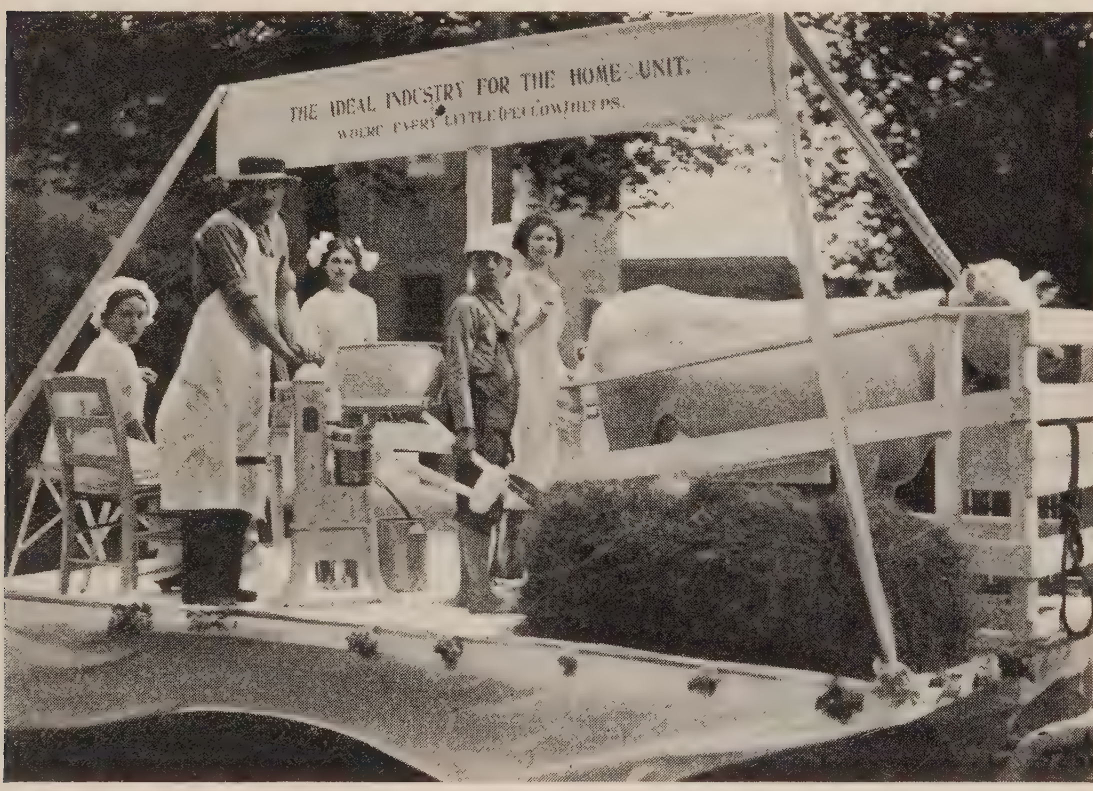

Fig. 5.—"The Ideal Industry," the one in which every little fellow helps and is strengthened thereby. The Dairy float during "county fair" parade by Agricultural College students, University of Minnesota.

of feed, labor and produce, it is often not easy to figure a "profit" in dairying when direct incomes only are considered.

Indirect Incomes.—Skim milk has a feeding value of 25 to 75 cents per 100 pounds, but after that it has a manurial value equal to about three cents per 100 pounds of skim milk consumed. Barnyard manure has a chemical value of from \$3 to \$3.50 per ton, yet possesses physical and bacterial values which aid materially in the production of larger crops. It is easy to

calculate the amount and market value of feeds consumed by cattle, but the fact remains that a considerable quantity of the stuff eaten throughout the year could not have been sold except through some form of livestock and therefore had no market value. The labor of caring for stock naturally should be charged against the income from the animal, but when such work is performed by the growing family who must be maintained in any case, to charge the animal would require a crediting of the system by an equal amount. Time is more fully utilized on

Fig. 6.—A Minnesota farm home in which a family of useful citizens was raised.

stock farms, especially on dairy farms (Fig. 6). Mornings, evenings, Sundays and holidays employed productively, even though at a moderate rate, are sure in time to amount to a considerable item. These are part of the indirect incomes or sources of profit derived from the employment of livestock, and this is more intensely true when the cattle employed are of the dairy sort, thus admitting of more labor and the consumption of a larger proportionate amount of coarse fodder.

Regulation of Farm Labor.—Most of the farms of this

country are so large that hired men either are, or should be, employed for the proper cultivation of the soil. With the increase of general education, culture and convenience of the farm homes it is becoming increasingly unpleasant to keep the sort of hired man, in most places available, in the home and at the table with the family. Their labor is desired, their society is not. A cottage built on the farm at some distance from the main buildings, where a hired man of steady habits, and family anchor, may be given quarters, has been found helpful in securing better grade men and in keeping them; but to make this profitable there must be ample employment at all times of the year. The dairy herd furnishes such employment.

Dairying on High-priced Lands.—It is not uncommon, even in this country, for good land near large cities to be leased for \$20 to \$40 per acre per year for truck gardening, or other intensive purposes. In some portions of Europe, however, notably in Holland and the Channel Islands, where land is seldom sold, farms frequently rent at from \$50 to \$75 per acre per year to be used for milk and butter production. The sale of high quality butter permits high rentals to be paid. Butter is a concentrated product of both labor and material. Dairying requires more labor than most other forms of livestock husbandry, yet recompenses well if done intelligently.

Balanced Farming.—The labor problem is difficult to solve under the one-crop system of farming. It is natural that the settlers of any new country should turn their attention to a few crops for which the place is best adapted, but to cling too long to the single crop has been shown to be unwise. Thus the north central portion of the United States suffered because her farmers clung too long to small-grain growing. Clover, cultivated crops and livestock were needed, and are now being introduced. The South, as a whole, has clung too long to the single crop, cotton. The boll-weevil may be doing for the southern farmers what the chinch bug did for the northern, forcing them to abandon the single-crop system and adopt crop rotation and the keeping of livestock. While in the West an insufficient number of cattle is kept, there are places in the East where too many are being

maintained for the available land. To ship grain 1000 miles to feed is to increase the cost of the cow's ration, and handicap her by that much. In many parts of New England a smaller number of more productive cows, fed far more largely from the home farm, will be found preferable to the present system of raising roughage and buying western grain.

QUESTIONS

1. What prices are paid as rental on land in America? Mention rentals paid in your section.
2. Which farm product is most valuable per pound, wheat, potatoes, eggs, or butter?
3. Why does dairying furnish a regular income?
4. What work about the farm is the child best adapted to do?
5. What is a direct income? An indirect?
6. What is skim milk worth per 100 pounds?
7. How does a dairy herd help to regulate farm labor?
8. Name two dangers involved in too high specialization in production.
9. What is balanced farming?

PART II

THE DAIRY BREEDS

CHAPTER IV

EARLY USE OF CATTLE

Cows, goats and sheep have been used by man, not only as flesh-producing, but also as milk-yielding animals, since a very early period; just when, will probably never be known.

If we go to one of our best records of ancient doings, the Bible, we find in Genesis 18 : 8 : "And they took butter and milk . . . and they did eat." Again, in Judges 5 : 25 we find: "He asked water and she gave him milk; she brought forth butter in a lordly dish." Those two passages would indicate the early use of butter as a food. That it was at least commonly known would be shown by the words of King David, Psalms 55 : 21: "The words of his mouth were smooth as butter, but war was in his heart." If the word here translated as butter did not stand for a substance well known, it is not at all likely that it would have been used to drive home such a thought.

Although the word itself must have been in common use, it is also quite certain that the substance, whatever article of our diet it may have resembled, was not so common as to cease to be considered a luxury. This is indicated in even a later period, for we find in Isaiah 7 : 22, after mention has been made of cows and goats: "And it shall come to pass for the abundance of milk that they shall give, he shall eat butter; for butter and honey shall every one eat that is left in the land." These four distinct references to butter have led some to believe that butter, more or less like the modern food of that name, was known and used at least 4000 years ago. They certainly do shed a ray of light on the beginning of dairying.

A closer study of the matter, however, reveals a rather uncertain condition. It is agreed by all scholars that the word "butter," as a translation of the Hebrew word in the Old Testament, is misleading. Gusenius in his Hebrew lexicon says of the word: "In no passage of the Old Testament does 'butter'

seem to be meant," and he defines it as "curdled milk" and "cheese." The earliest references to butter and butter making in Greek literature deal with its manufacture and use by the Scythians, and the earliest reference in Roman literature is by Celsus, who lived in the first half of the first century A.D.

From the various references it seems certain that the Greeks and Romans used butter sparingly, if at all as a food, although the surrounding people in Asia and in Europe used it freely, especially as an ointment. Pliny speaks of it as being used for

Fig. 7.—A profitless cow made so (probably) by poor treatment.

anointing and in all passages in which it occurs it is spoken of as something fluid and to be poured out, although, according to Hippocrates, the Scythians made butter by placing milk in a stone jar and shaking it until the fat rose to the top.

Our word butter comes to us from the Latin "Butyrum" and this in turn came from the Greek "Boutyron," which, according to the New International Encyclopædia, is from "bous," meaning cow, and "tyros," meaning cheese. From all the foregoing we may safely conclude that a rather soft cheese

was common and that the fat of milk was used for the purpose of anointing the body at an earlier period than it was used as a food, and that its place as a food is probably not much more than 3000 years old.

Our word "dairy" seems to have come to us through the old and middle English, "deieris," from "dey," meaning a maid-servant, especially one employed about the farm or livestock. We find the same in Norwegian "deia" as in "bu-deia," a maid-servant in charge of livestock.

During what is known as the "Middle Ages" and later, the

Fig. 8.—Sons of cows are the motors, the grass-engines in pioneer life. They will work where horses cannot go, live on coarse foods and become marketable beef when too old to labor. (Photo by G. G. Wiltse, Pine River, Minn.)

dairy cow as an instrument in human food production was developed most strongly in Holland and Switzerland.

The evolution of the dairy cow from some mediocre, early type animal (Fig. 7), to the present deep-bodied, capacious, wonderful machine, has been a more or less gradual process, but much more rapid during the past 200 years than during any previous time. It cannot be thought that any man schemed to produce an economical dairy worker and set about to develop that form now known as the dairy type, but rather that as individual cows varied slightly it was observed that some yielded more milk

than others and that these were naturally selected to be the mothers of other cows who were to work in a dairy way and thus gradually, almost unconsciously, the fundamental change took place.

The cow, for the pioneer (Fig. 8), especially on the frontier in this country, has been, and is, a God-send. For nearly 300 years in this country the home-maker with small means has, by the use of a few cows, been able to provide milk, meat and shoes, from these patient creatures. Among the stumps of the northern, cut-over timber country, or on the winter wheat pastures of our western prairies, she is still being used, not only as a provider of food direct for the family, but as a means of cash income as well.

QUESTIONS

1. What is our oldest record of the use of cows for dairy purposes?
2. From what old time word is our word "dairy" derived?
3. From what Greek words is our word "butter" derived?
4. What place did the cow and the ox hold during our pioneer days?
5. Why is not the ox more used at present?

CHAPTER V

ORIGIN OF BREEDS

It is a general truth that an abundance of feed promotes quick growth of the young and also encourages the production of a larger size. A condition wherein there is an abundance of feed through a long period of years makes for an increase in the size of the stock. This is undoubtedly the prime reason why the cattle of Holland are larger than other dairy breeds. The reverse is also true, scanty feed and severe weather retard growth and tend permanently to stunt the animals. Thus we find the cattle of our extreme northern regions naturally smaller and more agile than those farther south on more abundant pastures.

A classification of the original primary stock, so far as can be determined by fossil remains and the present representatives, would seem to indicate that at some very early period, for some unknown reason, the great family known as the *Bos* divided into two great divisions, one represented by the present hump-backed cattle of India and Egypt, known as the *Bos Indicus;* and the other represented by the present straight-backed cattle of northern Europe and known as the *Bos Taurus.* That they are of the same origin would seem to be indicated by the fact that they will readily cross breed and their crosses also breed. This division must have taken place at a very early period, however, because it is evident that a division of the straight-backed group later took place, and formed the large, fierce, long-headed beasts to which the name *Bos Primigenius* (Keller) has been given, and the smaller, almost deer-like race, possessed of finer qualities, and known by the comparatively short, broad skull. This division is known as the *Bos Sondaicus* (Keller). The present breeds and strains of the domesticated cattle of the world are almost wholly the refined representatives of the one, the enlarged representatives of the other, or a mixture of the two. The

present-day cattle of Holland, known in America as the Holstein-Friesian, are probably the best present representatives of the large race. The Jerseys are good representatives of the smaller race, while the Guernseys and most of the breeds of England and Scotland are doubtless mixtures of the two races.

Our present breeds were developed by keeping a few animals continually in a certain valley or on a certain mountain-side where they were subjected to the same feed and climatic changes, and where they were, so far as the group was concerned, inbred. The whim or fashion prevailing in one community would also make, in time, something different from that in an adjoining valley, even though the original stock may have been similar or practically identical. Thus we find that the little country of Switzerland has developed two major breeds, and several minor ones, while the various provinces of Germany, France, Austria and Hungary are represented by animals similar to but slightly different from those in nearby regions. In this way breeds have started, which when refined by skillful feeding, selection and breeding, have developed into the magnificent breeds of the present time.

The value of having pure breeds is chiefly that the man who selects cattle for any particular purpose may be able to choose by name essentially what he wants, and then be reasonably certain that the offspring shall continue to be of the same quality, whether it is meat or milk that is chiefly desired. It is of primary importance, therefore, that the breeds be made to stand for something definite, not only in the single item of economical milk or butter or beef production, but also in its other qualities which are the outward mark or proof of the breed, namely, such items as color, size and temperament. At present some breeders of both Jersey and Guernsey cattle prefer the large size with milder disposition, while others work for the smaller, more highly refined animals. The value of both breeds unquestionably has been lessened by these long-continued differences of aim on the part of the breeders. This seems inevitable in a large country and points to a reason why most of the prominent breeds have sprung from very small places.

A cross is an animal resulting from the mating of two animals of different breeds. The wisdom of such depends largely upon whether the two breeds are sufficiently similar to give fair guarantee that the progeny will not be more or less of a monstrosity. For instance, refined representatives of both the Jersey and the Guernsey breeds are as likely to produce an efficient dairy cow as could be expected from the mating of the large angular Jersey with a refined Jersey, while the crossing of the Holstein-Friesian with either the Guernsey or the Jersey is a practice never to be recommended. The differences in their organization are too great. Experience has shown that the progeny of such a cross is seldom as valuable as either parent for dairy purposes. The mating of extremes should be avoided.

Grades are the result of mating a pure-bred with common stock of mixed and uncertain breeding. A pure-bred animal is usually far more prepotent than the scrub or common animal. The qualities of the pure-bred animal usually manifest themselves in the improvement of the young towards the qualities of the pure parent. Thus, so far as the qualities are concerned, the cow resulting from the first cross may be said to be more than half of the blood of the pure parent. The next mating with a pure-bred should effect improvement, but such will not usually be nearly as marked. The bulk of the dairy work of this country must of necessity be done by grade cows for a very long time to come. Yet their qualities should be improved as rapidly as possible by grading up with a pure-bred sire and by better feeding and handling.

Our common stock are the descendants of the animals brought over in the colonial period and soon after. The foundation stock of the country differs. In the southern states the animals are largely the descendants of the Jerseys and Guernseys introduced to the country as Alderneys, and not kept pure. There is a considerable admixture also of the Shorthorn blood in the South and elsewhere. The early common stock of the northern states are very largely the descendants of the Dutch cattle brought over in the seventeenth century and mixed with Shorthorns brought over later. Recent importations and at-

tempts at improvement continually add fresh elements to the stock, but still the common cow of the middle west is largely of the Durham or Shorthorn characteristics, while those of New York State partake more of the Holstein nature and the New England States more largely of the Jersey. The pure breeds chosen by any sections are afterwards influenced by the type of the common stock and that in turn by the kind of farming carried on during any period of time in any section. Thus we find a considerable increase of dairy-bred animals in the north central states during the past twenty years with a rapid introduction of dairy sires at the present time.

QUESTIONS

1. Name the two grand divisions of the *Bos* family. What characterizes them?
2. Into what two classes did the cattle of Europe develop?
3. How were breeds of cattle naturally formed?
4. What is the value of having breeds?
5. What items should be included in the breed characteristics?
6. What is a cross?
7. What is a grade?
8. From what blood elements have the common cattle of your region descended?

CHAPTER VI

ELEMENTS OF DAIRY TYPE

"The productive capacity of a cow depends more upon type and conformation, than upon size or breed." [1]

It has long been recognized with some classes of animals that those of a certain conformation or type were better adapted to certain work than those of other build; thus the greyhound for running; the broad, massive horse for draft. But with cattle the efficiency of type has been slow of recognition.

The essential economy of the dairy type cow was first clearly demonstrated in 1894,[2] when it was shown that a "beef type" cow used 17.5 cents' worth of feed to produce a pound of butter fat, whereas a "dairy type" cow produced a pound for only 12.1 cents, it therefore costing nearly 50 per cent more feed to produce butter fat with a beef type than with a dairy type cow.

The matter was more fully demonstrated and clearly set forth, however, in 1900 [3] for dairy cattle, while in 1905 the desirability of the "beef" type animal where meat making is the principal aim, was shown experimentally.

The elements or factors of what is meant by dairy type may be summed up in a few paragraphs, as follows:

Capacity for consuming an abundance of feed is the most striking single feature of a cow possessing dairy type in marked degree. A large barrel is necessary for the mere holding of a large quantity of feed and the organs necessary for its digestion. The importance of this feature becomes strikingly apparent when we consider that the feed cost of maintenance of a cow is practically in proportion to her live weight. That is to say, two cows each weighing 1000 pounds will require for their daily support essentially the same amount of feed whether they are

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[1] Haecker, T. L., Minn. Bul. No. 35.

[2] Haecker, T. L., Minn. Bul. No. 67.

[3] Kennedy, et. al., Iowa Bul. No. 81.

able to consume a quantity much greater than maintenance or not. This may be illustrated by Figure 9 below.

Let the top line represent a cow of moderate feed-taking powers and her total consumption by the length of the line A C and her feed cost of maintenance by that part of the line represented by A B. Since A B amount is burned up daily to keep the animal warm and in strength it necessarily follows that only that quantity of feed represented by the short line B C can possibly be used for milk formation, whereas in the case of the second animal, assumed to weigh the same, therefore requiring approximately the same amount of feed for daily upkeep, namely, amount shown by line D E, being able to consume a quantity represented by D F and having a surplus shown by E F which is twice as great as amount B C, must, of necessity,

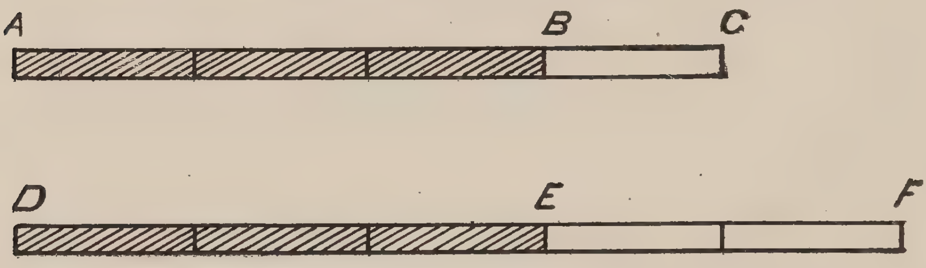

FIG. 9.—Illustrating need of capacity in cows.

after supporting herself, have left in her system twice as much nutriment for the formation of milk as the first cow. She has not consumed twice as much feed by any means, yet the surplus is twice as great.

This may be illustrated by two men. Smith earns $1 a day, or $6 a week. Jones earns $2 a day, or $12 a week. If it costs each $5 a week to live, Smith has left, at the end of the week, only $1, whereas Jones has $7. Jones took in only two times as much as Smith, yet has seven times as much surplus with which to do outside work.

The capacity of a cow is produced partially from the necessity of consuming liberal quantities of succulent roughage while in her young, growing condition, but to even a greater extent is produced after she starts milking. We must not look upon a cow as a machine into which we may stuff so much feed and

draw out so much milk. Her organization is not of that sort. The cow yields milk in response to the impulse given by motherhood. As the glands secrete milk and draw upon the blood and lymphatic system for material to transform into milk the cow's whole system, as it were, becomes hungry, and the cow in response to this hunger consumes liberal quantities of feed. Heavy consumption and the development of a large barrel then are effect, not cause. They are the result of the activity of the milk-secreting glands.

A cow may have capacity, however, without possessing dairy type. A high-class beef animal must have a good middle. Consequently the question naturally follows, "What will the animal do with the feed after she gets it?" and this brings us to the second element in dairy type.

Temperament.—A cow possessing what is known as dairy temperament is inclined to be alert and almost nervous, in fact, just the opposite of sluggish or sleepy. Dairy temperament, however, includes more than nervous organization, except as the nervous system affects the general physical condition. A cow with a thin neck, comparatively sharp withers, lean shoulders, prominent spine with the vertebra open, with thin thighs, slender tail, and refined legs, is one which will produce milk economically, provided the other essentials are present (Fig. 10). While it is possible to go so far with this matter of thin angular development that the animal will be too excitable and too tender to withstand ordinary conditions, it is also a fact that any animal which carries appreciably more flesh than necessary to perform her natural functions not only largely wastes the feed which was required to build the needless meat, but is also subjected to the constant expense or feed cost thereafter, of maintaining the heavier body (Fig. 10).

This may be illustrated by two men. A and D are farmers who have equal need for house room. A builds his house for \$3000 and uses all of it. D builds larger, his house costing \$4000, and he does not use all the space. D in this case has not only wasted the extra thousand in putting it where it can do no good, but will also be subjected to the constant expense

thereafter of maintaining in repair the unneeded and unused portion. Just so with the cow. She produces nothing, she only transforms. If she transforms into flesh an unduly large amount of feed consumed she not only has almost wasted the amount of feed required to produce this extra weight, but is also handicapped thereafter by being compelled to support or maintain a live weight larger than is needed for the work being done.

Dairy temperament suggests that lean but placid expression commonly found in the best dairy producers.

Constitution.—The question of the physical ability of the animal made up as just described to withstand the physical hardships of life continually arises. Any animal to be first-class must have constitution, but what is constitution? If we answer this question "Constitution is the ability of any animal

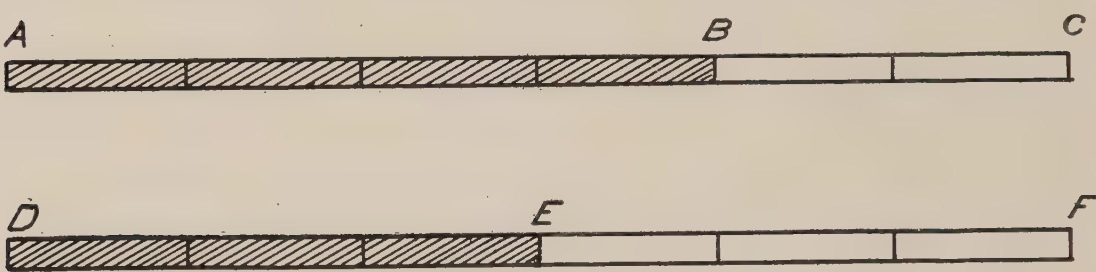

Fig. 10.—With equal consumption the cow that requires least for maintenance has the most left for production.

to perform its life work and remain in health throughout a reasonably long life," then we must conclude that the angular build of the dairy cow does not lessen its constitution. It is a popular notion that any animal to have constitution must have a broad as well as deep chest. Immature students often confuse fleshiness with constitution (Fig. 11). The dairy cow should have a deep chest and one moderately broad at the floor of the chest, or in other words, there must be room in the chest cavity for large lungs for the purifying of a large quantity of blood and for a large, strong heart for the pumping of this large blood quantity (Fig. 12).

Constitution includes, however, that intangible item of nerve. This element is best illustrated in the case of horses. Some thin, deep-chested horses are able to work, run or fight the larger, heavier horses literally to the grave. Another item

in this connection is that the resistance met by the blood in its circulation throughout the body is nearly, if not quite, as important as the actual pumping power of the heart itself. Any animal when fat, is at a disadvantage in that many, or all, of the finer blood vessels are surrounded by a more or less compact mass which not only reduces the size of the blood-vessels some-

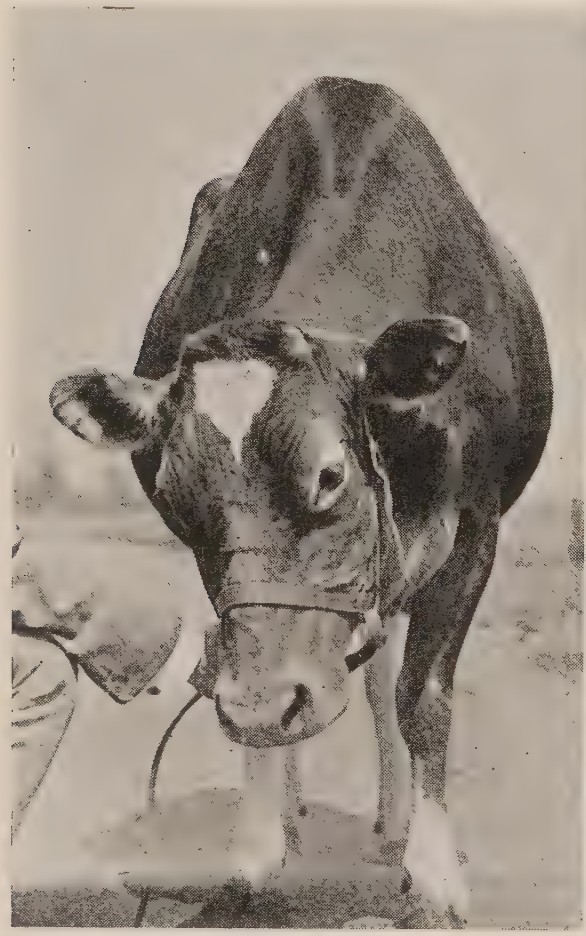

Fig. 11.

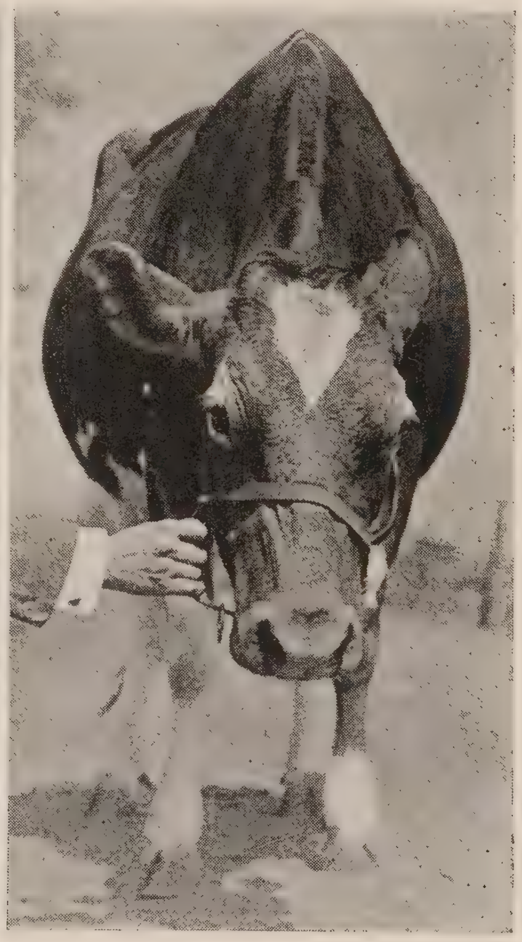

Fig. 12.

Fig. 11.—Showing coarse shoulders, an undesirable point.
Fig. 12.—Showing sharp, angular shoulders, desirable in dairy type.

what, but also renders them less elastic, less responsive to the pulsations of the heart. This throws a greater burden upon the heart itself. Given two animals with heart power equal, one animal in moderate flesh or lean, blood-vessels surrounded by loose connective tissue, the other with blood-vessels surrounded by fat, the leaner animal would be able to work or run longest and would be said to possess the strongest constitution. In

rating the constitution of the dairy cow, therefore, the resistance to the heart must be taken into consideration fully as much as the pumping power of the heart itself.

Mammary Development.—Not infrequently animals are met which have capacity in moderate degree, and certain constitution, and still do not yield milk as abundantly as we might think they should. Such animals are usually deficient in the mammary glands, something over which man as yet has little control. The economical dairy cow will possess an udder with connective tissue elastic and flexible. The good udder will milk out and become very flabby. The udder which is so meaty that it will hold its form after all the milk has been withdrawn is seldom found on a good dairy cow. Accompanying the well-developed udder are found large, crooked, elastic veins running forward from the udder to two or more points near the region of the heart. These so-called "milk veins" are filled with blood which has finished its work in and about the mammary glands, and we reason that if a large vein is needed to carry the blood which has been used in the gland, that the gland itself must be reasonably active. Certain it is that the most powerful dairy producers show veining in a marked degree, not only on the abdomen, but on the side of the udder as well (Fig. 19). The mammary system then furnishes an expression of dairy ability which must be considered along with the matter of capacity, temperament and constitution.

Femininity.—The yielding of milk is pre-eminently a function of the female. To be a good cow she must have the facial expression of a female, rather than a male. The bold masculine expression is seldom found upon a good dairy cow.

The triple wedge is an expression used formerly more than at the present time to designate the conformation or the type of dairy cow found to be the most efficient. Looking at the cow from her side, taking the nose as the thin edge of the wedge, we notice that the lines of the body draw continually farther and farther apart until upon reaching the region of the udder the lines are fully fifty per cent farther apart than at the chest, thus forming the shape of a wedge. The second wedge form would

be noted if we could look down upon the back of the cow. The thin edge of the wedge would be forward, the body of the cow becoming wider towards her rear until the region of the paunch has been reached, where the greatest dimensions will be shown. The third wedge is seen by looking at the cow from the front. The sharp edge of the wedge will be her shoulders, the wedge thickening as it goes downward until a point at the floor of the chest has been reached. Cows built thus, however, usually spread their front feet slightly, thus continuing the wedge to the ground. May Rilma, Fig. 2, illustrates the point of this paragraph.

The escutcheon is that area of the cow situated immediately above the rear portion of the udder and extending upward and laterally onto the thighs, on which area the hair naturally turns upward rather than downward. Particular attention was first drawn to this mark by Francis Guenon, in France, prior to 1837. Mr. Guenon classified the various kinds of escutcheons into eight classes and eight orders, making sixty-four different combinations, to each one of which he affixed a figure which he calculated would be the amount of milk which that cow would yield under good treatment in a year. His statements were so positive and his description so exact that universal credence was given to the theory. He was honored and pensioned by the French Government. The breed associations almost universally adopted the escutcheon as a point of excellence and it has been retained on most score cards until the present. With no exact comparisons, however, the universal belief in the value of the escutcheon has died out until few can be found now to defend its presence on the score card of the modern breeds. More exact evidence of the fact that there is little or no merit in the escutcheon was furnished by Charles Moran, senior student at the University of Vermont, in 1910. His study, covering a year of record of one hundred cows in three herds, showed no consistent agreement between the quantity or the quality of milk which the cow was supposed to give according to the Guenon theory and the amount she did yield as measured by daily weighings and the Babcock test.

Tests of Economy.—The efficiency of cows possessing the dairy type as against those not having such form was well brought out by the figures contained in Minnesota Bul. No. 67 (1900), from which the following tables are arranged:

Test I

	Dairy Type	Not Dairy Type
Gross receipts	$77.77	$54.40
Cost of feed	30.82	28.21
Net receipts	$46.95	$26.19
Amt. returned per $1.00 worth of feed	2.52	1.93

The dairy-type group consumed 9.25 per cent more feed, but yielded 43 per cent more butter. On the average they consumed $2.61 worth more feed per cow but returned $21.76 more for butter.

Test II[4]

	Dairy Type	Not Dairy Type
Gross receipts	$41.55	$28.03
Cost of feed	15.14	13.86
Net receipts	$26.41	$14.17
Returned per $1.00 expended	2.74	2.02

The group of dairy-type cows returned nearly twice as much profit so far as dairy returns are concerned as the non-dairy-type group.

Test III

	Dairy Type	Not Dairy Type
Gross receipts	$75.71	$51.01
Cost of feed	37.60	30.64
Net receipts	$38.11	$20.37
Return per $1.00	2.01	1.66

The dairy-type group, on an average, consumed 22.7 per cent more feed but returned 48.4 per cent more butter and 87

[4] This winter's work was done when feed was unusually cheap.

per cent more profit. It consumed $6.96 worth more feed per cow but returned $17.74 more profit.

Test IV

	Dairy Type	Not Dairy Type
Gross receipts	$80.26	$48.83
Cost of feed	23.35	22.11
Net receipts	$56.91	$26.72
Return per $1.00	3.43	2.21

FIG. 13.—Young cow, a bad rump, poorly developed udder, and lacking in thrift and vigor.

The dairy-type group consumed 5.1 per cent more feed but returned 112.9 per cent more profit. They average, per cow, $1.24 worth more feed but returned $31.43 more for butter.

The above "tests" represent a winter's work on from five to ten cows in each group. The figures prove that, dairy production alone considered, the cows of essential dairy type are pronouncedly more economical and profitable than those of non-dairy type.

A secondary lesson, yet a valuable one, brought out in the foregoing study, is the fact that the common and non-dairy type cow when treated rationally is considerably better, even in the dairy, than no cow at all. When charged with feed at farm prices and credited with butter fat only (skim milk, manure and calf paying for labor, etc.) they returned from $1.66 to $2.21 for every dollar's worth of feed eaten.

The farmer should hesitate long before selling off his cows until he knows where he can replace them with better ones (Fig. 13).

A CHAMPION COW

The perfection already reached in the various points, as well as the degree of intensity desirable in them, varies with the several breeds, but reviewing the question of dairy type by means of figure 14, we find that our present ideal of what a dairy cow ought to be will include the following points:

1. Nostril, open, clear.
2. Muzzle, broad and lips strong.
3. Forehead, broad.
4. Eyes, bright, full.
5. Jaws, strong, well muscled.
6. Neck, muscular but not thick.
7. Shoulder tops, sharp, at least not coarse or heavy.
8. Crops, well muscled.
9. Chine, vertebræ open-spaced.
10. Loin, broad and strong.
11. Rump, level, long.
12. Hip bones, broad between joints.
13. Thurl joints, high far apart.
14. Pin bones, prominent, far apart.
15. Tail, long, tapering.
16. Switch, full brushed.
17. Thigh, straight or incurving, not too thick.
18. Shoulder, lean, firm, not covered over with fat.
19. Dewlap, not heavy, throat clean.
20. Brisket, more prominent on some breeds, not coarse.
21. Heart girth, deep, and wide from side to side at bottom of chest.
22. Milk wells, large, numerous.
23. Milk vein, large, crooked, elastic and running well forward.
24. Fore udder, extending well forward.

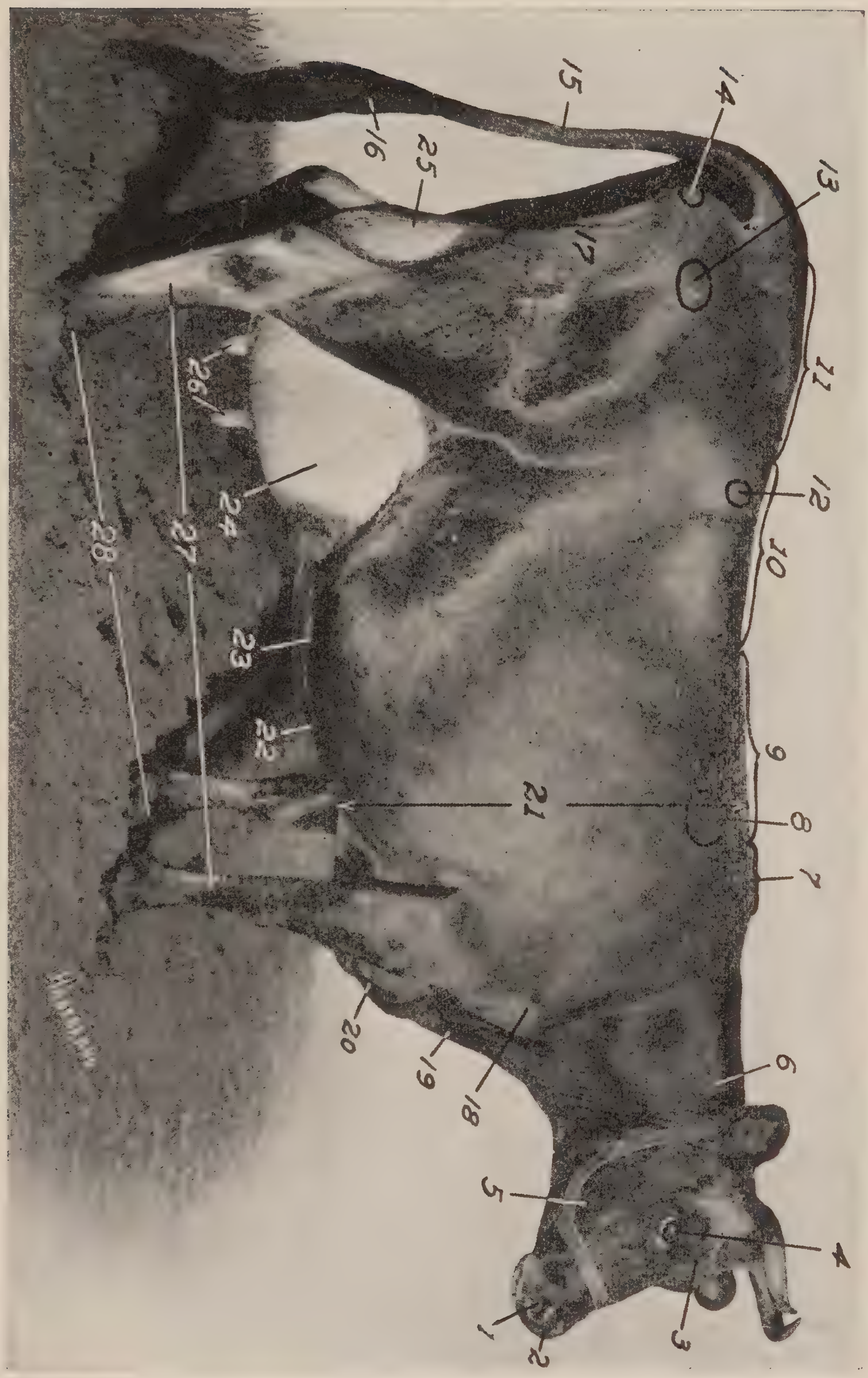

Fig. 14.—The points of the cow.

25. Rear udder should be full and attached high and broadly, whole well held up, not pendulous.
26. Teats, four to five inches long. Well spaced, cylindrical in form.
27. Legs below hock and knee refined, not heavy nor coarse.
28. Pasterns, strong, upright.

Type Essential to Economy.—There are numerous instances of cows producing large yields of milk and milk fat, which cows carried more flesh than is usually accepted as most desirable in dairy cows, but it has not been shown that these large-producing cows necessarily yielded milk as economically for the feed consumed as those of large capacity, carrying less flesh. While it is true that type is primarily more essential than breed, it is equally true that within certain breeds the desired type is far more likely to be found than in others. Thus any farmer desiring cows which will give milk economically will do wisely to go to one of the recognized standard dairy breeds for his stock, and it is only by maintaining pure breeds and by working within the breed to develop the strongest dairy type that we shall secure in time the most efficient dairy animals.

QUESTIONS

1. What is meant by dairy type?
2. What is meant by capacity?
3. Does a cow develop capacity by eating or does she eat because she has capacity?
4. Illustrate how it is essential that a cow have capacity if she is to be rated as a good dairy cow.
5. What is meant by dairy temperament?
6. What are the indications of dairy temperament?
7. What is constitution?
8. What effect has fatness on the work to be done by the heart.
9. What conditions of the mammary organs indicate high dairy quality?
10. Why is the feminine "look" of a cow a point to be noted?
11. Explain the "triple wedge."
12. Which was recognized first, breed or type, as being the more essential in economy of production?
13. Does excessively large production mean economical production?
14. Where should one look for the type of animal desired?
15. What is the escutcheon, and of what importance is it?

CHAPTER VII

THE BREEDS OF CATTLE

There are in America seventeen or more distinct pure breeds of cattle and many grades and crosses of each breed. The great mass presents similar general qualities, but groups and individuals differ in vital detail with respect to degree of usefulness for any particular purpose. Some are blocky with broad backs and are known as beef breeds, while others are more angular in form and thinner over the shoulders, and are known as dairy animals, yet there is no cow so strongly bred for beef that she will not give some milk, which milk may be and occasionally is drawn by hand and turned into dairy channels. All the breeds of pronounced beef-type cattle yield milk considerably above the average in fat content. There is no cow, on the other hand, so intensely bred for milk production but that she does develop a body which may be and regularly is used for human food when she is past usefulness in the dairy. It is a matter of common knowledge and record that even the "common to fair" cows sell for beef at from $40 to $60 regularly on the open market. This is fully one-half the price per pound paid for good, well-finished beef steers, while a steer from one of the admitted dairy breeds, such as Holstein, Ayrshire, or Guernsey, is cut in price only one-half to one cent per pound from that paid for good, beef-bred cattle. The loss in beefing the male calves of dairy cows is therefore not a total, but a fractional one and amounts to only 7 to 15 per cent of the amount paid for top-notch cattle.

That many of the heavy breeds, such as Red Polls, Brown Swiss and Shorthorns, will yield more freely than has for years been required of them, has been well demonstrated within the last few years.

The meat- and the milk-producing ability of the great mass of cattle in this country may well be represented by figure 15.

A glance at the diagram emphasizes the fact that "beef"

cows do yield milk and that "dairy" cows do have bodies and will also indicate that there may be (and we know there are) masses of cattle occupying places all the way from one end of the diagram to the other.

At this point the question naturally arises: "What is a dairy cow?" "When is a cow a dairy cow, and when is she a beef cow, if in fact she both functions and is used in both fields of usefulness?" While any one certain breed will occupy a fairly definite position on the scale at "a" or "j" or "e" or "h," individual members of all the breeds will vary so greatly as to lap over onto the position normally occupied by another breed. Furthermore, there are strains of common cows in some sections of the country that would as a whole occupy a position about "b" in meat and "j" or "i" in milk-producing ability. This is as a class the "scrub" cow that is to be gotten rid of.

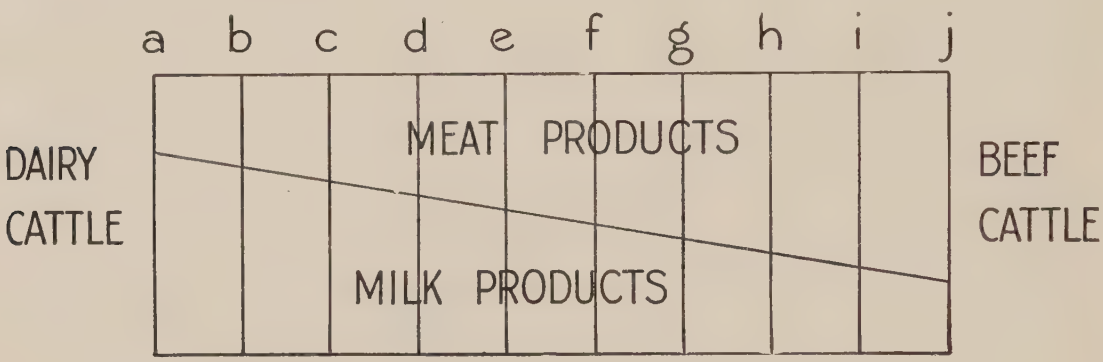

Fig. 15.—Illustrating the dual function and use of cattle.

There are others, however, that will rank about "c" or "d" in milk products and "h" or "i" in beef products.

Those animals that have been selected, fed and handled chiefly for the production of milk, are known as belonging to the "dairy" breeds, and those in which the production of flesh for meat has been the principal aim are known as "beef" breeds, while those animals that have been bred, fed and handled to occupy a midway position, are in America called "dual purpose" and in England "general purpose" cattle. They could as aptly be termed "heavy dairy" or "free-milking beef" cattle. In truth, all cows are dual-purpose cows, in function and in fact.

By name the breeds of domestic cattle now regularly bred in America are: Aberdeen Angus, Ayrshire, Brown Swiss,

Devon, Dexter, Dutch Belted, Essex, French-Canadian, Galloway, Guernsey, Hereford, Holstein-Friesian, Jersey, Kerry, Red Polls, Shorthorn, and West Highland.

In the following pages those breeds of cattle will be discussed which have any particular claim on the subject of dairying in America and have been arranged in the order of official records as to quantity of butter fat produced in a year, regardless of the cost of its production. On January 1st, 1917, the order was: Holstein-Friesian, Guernsey, Jersey, Ayrshire, Red Polls, Brown Swiss, Shorthorn, Dutch Belted and French-Canadian.

The most pronounced beef-type cattle, such as Hereford, Angus, and Galloway, are so seldom used for dairy purposes and are so pronouncedly good in meat food production, and several other breeds are represented in this country by so few animals that no detailed study of them will be made in this volume.

Secretaries of Breed Associations.—The various breed associations naturally change secretaries as seldom as possible. For this reason the names and addresses given below for the breeds discussed in this book are very likely to remain correct for a number of years.

Breed Name	Secretary's Name	Secretary's Address
Ayrshire	C. M. Winslow	Brandon, Vermont
Brown Swiss	Ira Inman	Beloit, Wisconsin
Dutch Belted	E. J. Kirby	Covert, Michigan
French-Canadian	J. A. Couture	49 Rue Des Jardins, Quebec, Canada
Guernsey	W. H. Caldwell	Peterboro, N. H.
Holstein-Friesian	F. L. Houghton	Brattleboro, Vt.
Holstein Adv. Registry	M. H. Gardner	Delavan, Wisconsin
Jersey	R. M. Gow	324 W. 23rd Street, New York, N. Y.
Red Polls	H. A. Martin	Gotham, Wisconsin
Shorthorn (milking)	F. W. Harding	13 Dexter Street, Chicago, Illinois

QUESTIONS

1. How many pure breeds of cattle are there in America? Name them.
2. What is a "dairy breed"?
3. Explain how all breeds are two-purpose breeds?
4. What nine breeds of cattle in America are considered in this dairy study
5. What three beef breeds are seldom or never used for dairy purposes?

CHAPTER VIII

HOLSTEIN-FRIESIAN

This breed is one of the oldest, of either beef or dairy animals, represented in America. It had its beginning in Holland, chiefly in a northeast province, Friesland, and is unquestionably the same which made the Hollanders famous throughout the civilized world more than a thousand years ago. Even back during the flourishing days of the old Roman Empire, large, black and white oxen, and cheese were continually being sent from the regions now known as Holland. A race of cattle with many of the present characteristics of the Holstein-Friesians doubtless were being maintained practically pure fully 2000 years ago and Holland has remained famous as a dairy center during the centuries since.

Though the parent stock has been kept pure, many off-shoots and modifications have taken place in surrounding countries; thus, modified Holland cattle are to be found in various parts of Belgium, Prussian Holland, North Germany, Germany, and to some extent in Normandy of France. This blood contributed to the development of the early Teeswater cattle, now known as Durham or Shorthorns, as well as having also furnished foundation for much improvement effected of late years in portions of Russia. This breed is believed also to have been used to some extent in establishing the Ayrshire breed.

Home Conditions.—The land upon which this breed of stock has been pastured for many generations is largely of a low, marshy order; in fact, much of the land is that reclaimed from the ocean by the thrifty Hollanders, who diked across the arm of the sea and literally pumped the water back into the ocean by means of windmills. The land thus reclaimed is immensely fertile but, being lower than the level of the ocean, continues moist and comparatively cold. Grass grows luxuriantly, while such crops as our American corn are not grown at all and small

grains but slightly. Upon these moist, rank pastures the cows are pastured in summer. They are not permitted to roam about, however, as in this country, but are tethered out. This system of feeding and handling is ideal for the production of bodily size and a quiet disposition. The grass literally grows up before them and after them. Milking is done in the field by the dairy maids, rather than fatigue the cows by walking them to a stable. They are likewise protected from chilling rains and from flies by blankets. An abundance of succulent feed, close at hand, and a protection from all adverse conditions, —these are the circumstances which naturally make for size of animal, quiet disposition and an abundant flow of milk, although of medium to low fat grade.

Great care is taken to rear breeding stock from the best animals only, since the land is valued at from $1000 to $2000 per acre, and brings an annual rental of $30 to $50 per acre. Under such conditions only the genuinely profitable animals will be kept. Surplus calves are fatted for veal. To do this most economically the little animals are kept in crates in order that they may not run about and waste any of the milk that has been fed them. They are also kept in semi-darkness in order that the gain may be more economically made.

Body Characteristics.—The color of the Holstein-Friesian in this country is always black and white. Very rarely, indeed, a red and white animal is dropped from pure parents, but it is not eligible to registry. The size is large. A mature cow should weigh 1300 pounds, and not infrequently individuals attain 1500 and occasionally 1700 pounds. A mature bull of this breed (Fig. 16) should weigh at least 1800 pounds, and 2200 or 2400 pounds are not infrequent in fully matured animals. The disposition of the Holsteins, as a breed, is very mild, in fact, they are so quiet as to be one of the easiest breeds to handle. They are not resentful. They are greedy, almost voracious, in their eating habits and naturally they are not as particular in regard to the condition of their feed as are some of the more sensitive breeds. The calves weigh ninety pounds or more at birth and are easy to raise. As a breed they are com-

paratively slow in maturing, however, thus postponing the time of income somewhat longer than with the smaller breeds.

Dairy Characteristics.—The Holsteins as a breed may be said to produce the largest quantity of the leanest milk of any of the breeds in America. Though the fat percentage is comparatively low, the fact that she yields such liberal quantities of milk has made her an easy leader in the matter of total food production and again very recently the leader of all the breeds

Fig. 16.—King of the Pontiacs. Holstein bull, which at the age of ten years had 162 A.R.O. daughters. Developed and owned by Stevens Bros. Co., Liverpool, N.Y.

in the quantity of fat produced in a year (Fig. 17). The table given later in this chapter shows the milk and fat records of some of the best representatives of the breed.

Not only is the percentage of fat in the milk of the Holstein rather less than that in other breeds, but the size of the fat globule is slightly smaller. This fact has been stressed in the matter of choice of milk for infant feeding (Fig. 130). It has recently been shown, however, that the difference is so slight as to be all but negligible.[1] The great benefit to be derived from

[1] Vermont Bul. No. 195, 1916.

the use of Holstein milk for infant feeding is due to the smaller amount and the smaller proportionate amount of fat present rather than to the small size of the fat globule. The milk of the Holstein carries a comparatively higher amount of albumen to casein. This fact may have a slight value in infant feeding. Before the invention of the centrifugal cream separator the fact that the Holstein fat globule was small rendered this breed doubly handicapped in the matter of butter production, since

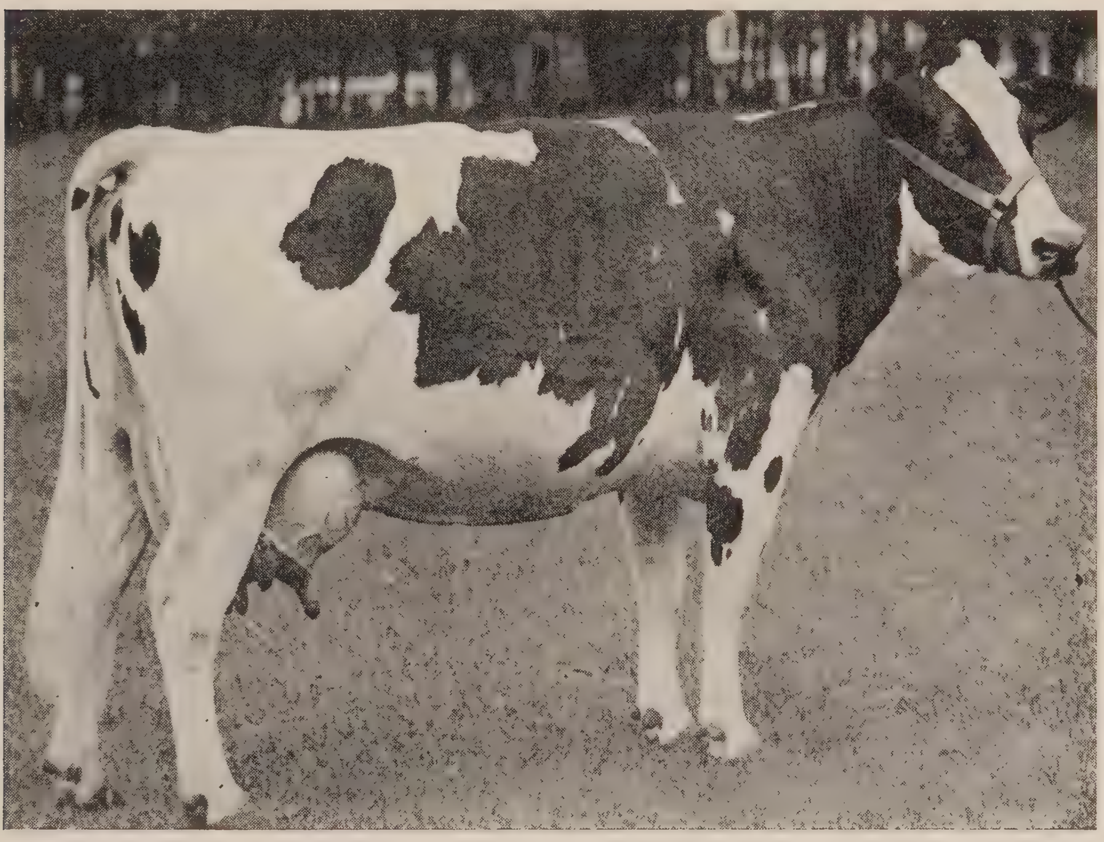

FIG. 17.—Duchess Skylark Ormsby, the world's champion in butter fat production. Record for one year: Milk, 27,761 pounds test, 4.34 per cent fat; butter fat, 1205.09 pounds, equivalent to 1507.36 pounds of 80 per cent butter. Developed and owned by John B. Irwin, Minneapolis, Minn.

the cream of Holstein milk cannot rise as promptly nor as completely as that on the Jersey or Guernsey milk. The lack of color, too, is an item in some markets. Holstein milk is particularly devoid of the yellow color. The color of milk or cream, however, is an exceedingly poor gauge of its richness and is of no consequence in commercial butter or cheese making. Cows of this breed have held for years the world's record for butter production as well as for milk production. Taken in her

entirety, the Holstein cow is one of the most powerful and valuable dairy machines.

Beef Characteristics.—Since the laws of animal breeding are but poorly known by any one and are difficult of control by the best, we must expect that as variations occurred and individual preferences varied, the stock even in the older countries, should vary somewhat in their intensity of dairy type. In some descriptions of the breeds four forms have been recognized, namely: the milk form, the milk and beef form, the beef and milk form, and the beef form. The Holsteins, however, are not first-rate beef animals since they are of slow maturity, comparatively heavy of bone and seldom place the gain either where it will be most valuable or in the most valuable condition when rightly placed. Although the prejudice on the part of buyers has doubtless caused a greater difference in price than the actual difference in carcass would warrant, it must be admitted that a general difference exists. A Holstein steer will gain in weight as rapidly and as cheaply as any animal, however, and will be but little less profitable than beef-bred steers. Grade Holstein bull calves make a good grade of veal and since they weigh from 90 to 100 pounds at birth, they may very readily be made to weigh 190 to 200 pounds at eight to nine weeks of age.

Introduction to America.—The first importation of cattle from Holland occurred in 1609, or soon thereafter, upon the settlement of New Amsterdam, now New York, by the Dutch. Other consignments were received for the Dutch holdings farther west in the state, but all these animals were not kept pure. They formed, however, the foundation stock for that section of the country and to-day New York state may be said to be the Holstein center of the United States. Others were brought over in 1795 and added to the general stock of the country. The first to be imported and kept pure arrived in 1861 in Massachusetts. From 1875 to 1885 about 10,000 were imported. From 1885 until 1903 few, if any, came over, partly because of the presence, in Holland, of the foot and mouth disease and partly because of the high charges for the registration of the imported animals.

The first American association for this breed was called the Holstein Herd Book Association. It was established in 1872. In 1879 the Dutch-Friesian Association was formed. The former Association was formed chiefly with the animals imported from the province of Holstein, North Germany, while the Dutch-Friesian Association admitted the animals which had been imported from Friesland, Holland, and their descendants. The uselessness of maintaining two associations when the animals in question were essentially the same was apparent and in 1885 they were united under the name, "The Holstein-Friesian Association of America."

At the present time the breed ranks in number second only to the Jerseys in America and, in some places, especially the northwest regions, are gaining more rapidly than any other dairy breed (Figs. 18, 19 and 20).

Foreign Distribution.—This Holland breed is now represented in most of the civilized countries of the world. It is not only common in Germany, France and Sweden, and in favor with the Boer farmers of South Africa, and the peasants of Russia, but also is to be found in liberal numbers in Japan, Mexico and South America.

Adaptations.—There are certain places which the Holstein cow fits better than any other breed: First, as the market milk cow. Since she produces the largest quantity of milk, the cheapest milk, and milk which is fully as rich as the people of the city seem willing to pay for, she is almost universally adopted wherever the product is to be sold by the quart or gallon.

Second, as a cheese factory cow she excels because she produces more pounds of milk solids during the year and therefore makes more pounds of cheese than any other breed. The fat content is so low that the cheese would be improved by the addition of the milk of the Jersey or Guernsey, yet when the cheese maker does his part well there is no necessity for introducing the milk of any other breed for the purpose of producing quality.

Third, milk condensing. In regions of milk condenseries, the Holstein is largely preferred, chiefly because she will pro-

duce more pounds of total solid matter in her milk than the other breeds. Thus, any farmer keeping Holsteins would be able to deliver to the factory more milk from which more condensed milk can be made.

Fourth, in very large dairies the milking must of necessity be done either by a large number of hired men who are, as a class, notorious for their unreliable habits and not particularly disposed to be gentle in their manner or particular about the milk, or

Fig. 18.—Sir Beets Cornucopia Netherland. A champion Holstein bull owned by W. S. Moscrip, St. Paul, Minn.

by the use of some milking machine. The mechanical milker is an unsympathetic thing at best, but the Holstein cows are very docile and while not as responsive to caresses as are the Jersey or Guernsey, they are not as resentful of coarse handling.

Fifth, from the drift of affairs in the middle west and northwest countries, as well as from a study of the cows themselves, it seems evident that the Holstein is rather better adapted to the needs and conditions of the general dairy farmer than any other dairy breed. The man whose first interest is his fields is not

likely to stop his gang plow early in the afternoon to stable the cows even though it is becoming chilly, and cows so situated often must go out of the stable in the morning before the farmer goes to the fields with his teams. The quiet, deep-bodied Holstein is proving herself able to withstand such conditions. Moreover, on such farms a comparatively large number of pigs are kept. To put young pigs in the best condition and to make the best use of the corn, fed later, skim milk is needed. When skim

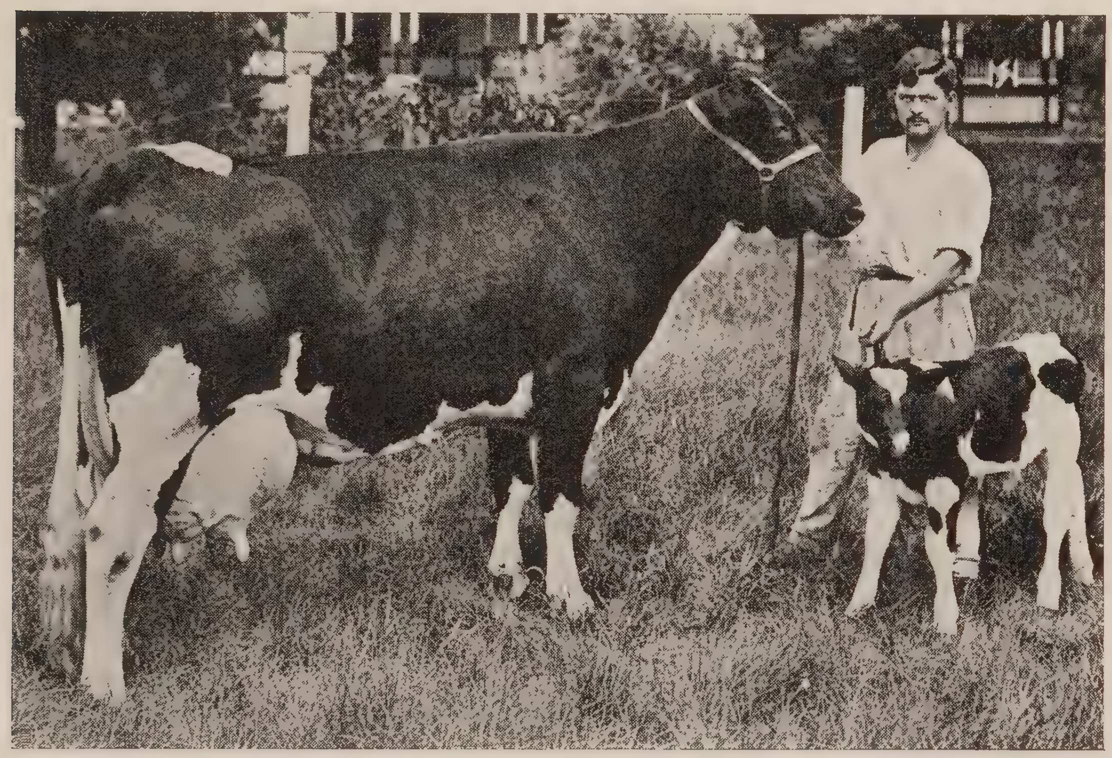

FIG. 19. —Pietertje Maid Ormsby—Adv. Reg. Holstein cow, nine years old, with seventh calf. Heavy production does not necessarily "burn out" the cow. Owned by John B. Irwin.

milk is present the sows may be made to farrow both spring and fall without injury to either litter or dam. When the indirect income from pigs, calves, and not infrequently colts, is considered, with the direct income from the sale of butter fat, the Holstein has little to fear in the competition with those breeds which produce butter fat more cheaply per pound.

Records.—During the earlier days of all the breeds, records, if kept, were private. From some of these unauthenticated

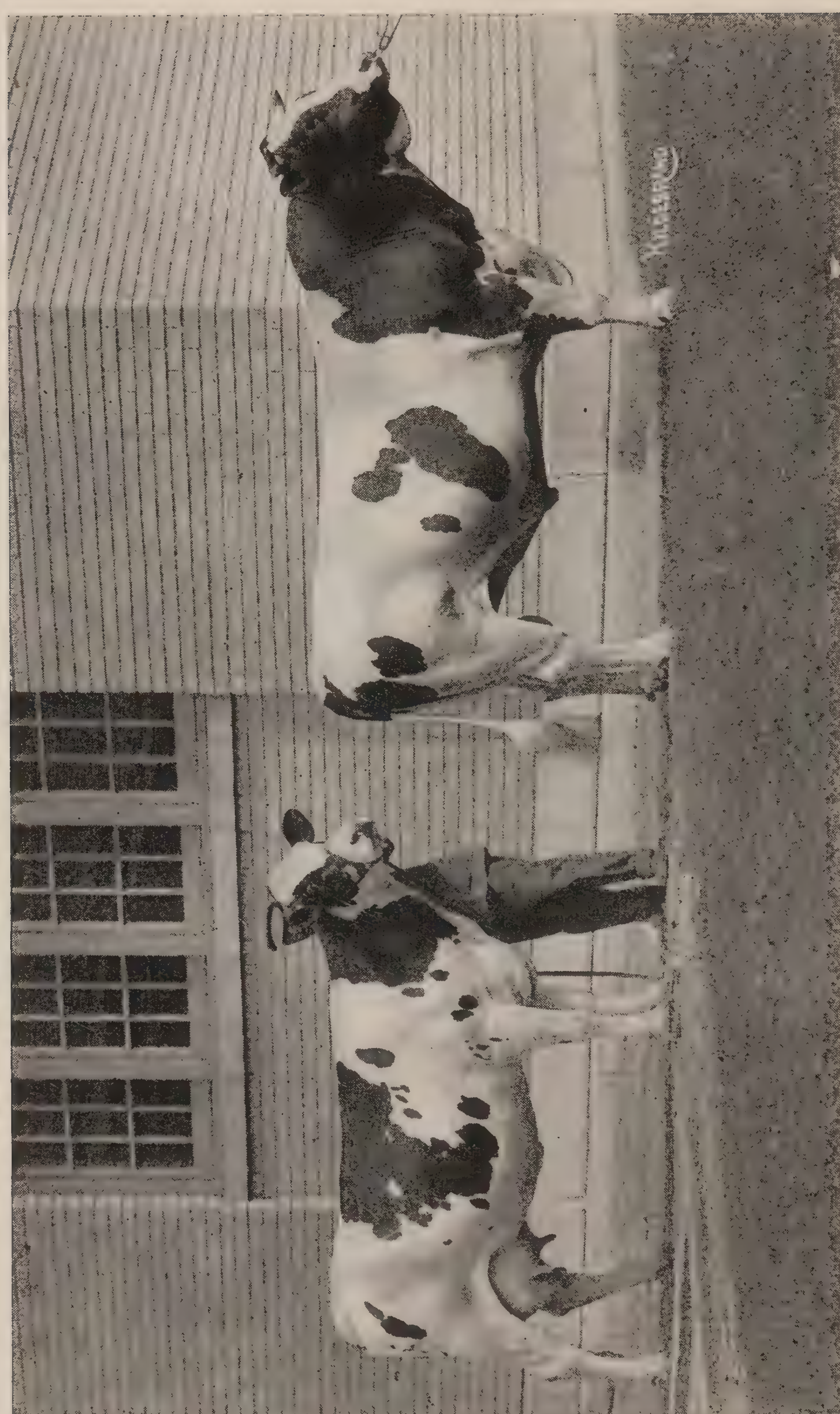

FIG. 20.—Holstein Bull, Paul Calona, and daughter. Note the rugged character of both. Owned by R. E. Haeger, Algonquin, Ill.

sources wonderful performances have been reported. Though they were held to be questionable at the time, many, if not all, have since been equalled by animals working under official supervision.

The Advanced Registry system was begun by the Holstein breeders, and Mr. S. Hoxie, of Yorkville, New York, should be given the credit for having developed the system by which the various State Experiment Stations and Agricultural Colleges are now authorized to send out official testers to verify the records made. This association was the first to adopt the Babcock test as the official method of determining the fat. This was done in 1894. While at first the records were reported in terms of butter at 80 per cent fat, the rules were later modified so that the official reports now are upon the basis of fat only. To convert the quantity of fat to butter equivalent it has been customary to add one-sixth of the fat to the fat. In the study of any pedigree note should be made as to whether the records are in terms of fat or in terms of butter, and whether the butter was figured on the basis of 80 or of 85 per cent fat.

The minimum requirements for the admittance of a Holstein to advanced registry are as follows:

2 years old........	7.2 pounds of fat in 7 days.
3 years old........	8.8 pounds of fat in 7 days.
4 years old........	10.4 pounds of fat in 7 days.
5 years old........	12.0 pounds of fat in 7 days.

These requirements were established when cows were not as well fed nor as skillfully handled as now. The question may well be raised whether the requirements for admission should not now be raised. This would seem evident from the number of animals capable of passing the advanced standing, and the fact that a number of animals have more than doubled the requirements. The animals standing highest in the seven-day records up to March 1, 1916, were as follows:

	Advanced Registry Number	Herd Book Number	Lbs. Milk	Lbs. Butter Fat
K. P. Pontiac Lass	11168	106812	585.9	35.343
Valdessa Scott 2nd	10780	72311	694.6	35.500
Sadie Vale Concordia 4th	10840	100314	691.4	32.848
Mable Segis Korndyke	22540	161784	610.2	32.257
Johanna De Kol Van Beers	5981	75131	663.4	32.059
Sadie Vale Concordia 4th Pietertje	24966	142024	729.5	30.741
Peterje Floa Artis	15161	114334	794.5	30.513
Pontiac Lady Korndyke	11276	92700	601.4	30.422
Pontiac Pet	6168	69710	590.7	30.142
Belle Mercedes Lady	22258	77702	721.6	29.968

It will be noted from the above that there are many cows which are doubling admission requirements and a few which are able to produce almost three times the required amount.

Yearly Records.—Early records were largely reported in the form of pounds of milk yielded in a year. A few of the best of the yearly records are reported below:

Pietertje 2nd	26,021 lbs. milk in 1 yr.
Princess of Wayne	29,008 lbs. milk in 1 yr.
Clothilde	26,021 lbs. milk in 1 yr.
Clothilde 2nd	23,602 lbs. milk in 1 yr.
Sultana	22,042 lbs. milk in 1 yr.
Boukje	21,679 lbs. milk in 1 yr.

Fat records were not made from these animals. Recent yearly records have not only been authenticated by qualified and impartial representatives of the state but also are made to include the fat as well as the milk yielded.

Requirements for Official Yearly Records.—Cows freshening at two years of age or younger must produce 250.5 pounds of butter fat, and for each day they are over two years of age, at the beginning of the test, an additional requirement of 1/10 pound. This rate of increase for each day over two years of age brings the five-year age requirement up to 360 pounds of butter fat. Bulls are required to have two daughters in the Advanced Registry before they can be listed as Advanced Registry Sires.

A few of the best official records made by mature animals for a full year are shown below:

Semi-Official Yearly or Lactation Records for Full Aged Cows

	No.	Pounds Milk	Pounds Fat
Duchess Skylark Ormsby	124514	27,761.7	1205.09
Finderne Pride Johanna Rue	121083	28,403.7	1176.47
Finderne Holingen Fayne	144551	24,612.8	1116.05
Banostine Belle De Kol	90441	27,404.4	1058.34
Pontiac Clothilde De Kol 2nd	69991	25,318.0	1017.28
High-lawn Hartog De Kol	84319	25,592.5	998.34
Colantha 4th's Johanna	48577	27,432.5	998.26
Lothian Maggie De Kol	90209	27,967.6	990.80
Maple Crest Pontiac Flora Hartog	143950	25,106.3	986.11
Crown Pontiac Josey	101812	28,752.3	982.23

It will be noted that all the claims made for the cows in private records have been equalled in recent years, so whether the earlier reports were true or not it is evident that they could have been.

The breed's future depends very much on what the men who are now breeding the animal make it, and this in turn upon the completeness of the ideal for the breed formed, held and followed by the breeders.

That there are now, inherited from the earlier workers, several points about the animal that need strengthening cannot be gainsaid. A study of the animals as they are, reveals the fact that a great many, even among the pure-bred herds, are long legged, high and "upstanding" with shallow body and indifferent udder. Such should be and are being eliminated but not fast enough. Others are too compact in build, too beefy in type to be economical producers. It is true that breeding to sons of advanced registry [2] cows, tends to eliminate these two classes of undesirable animals. It has often led into another error, less vital yet worthy of consideration, and that is the sloping rumps or rumpiness. Many animals possessing ugly shapes yet having deep, strong bodies have made very satisfactory records. While it is true that it is yield, not form, that should be first sought, it is equally true that cows may be both good and good to the eye. While the demand is keen for stock the bad rumps may pass, but the calls of the near future will be for breeding stock from advanced registry dams, which are also possessed of straight top lines and well balanced udders. The wise breeder of the present will plan to have the stock to meet the demands of the near future.

[2] Official advanced registry is designated by the letters, A. R. O.

Scale of Points for Judging Holstein-Friesian Cows

Parts	Description	Possible Score	Student's Score
Head	Decidedly feminine in appearance; fine in contour	2	
Forehead	Broad between the eyes; dishing	2	
Face	Of medium length; clean and trim, especially under the eyes; showing facial veins; the bridge of nose straight	2	
Muzzle	Broad with strong lips	1	
Ears	Of medium size; of fine texture; the hair plentiful and soft; the secretions oily and abundant	1	
Eyes	Large; full; mild; bright	2	
Horns	Small; tapering finely towards the tips; set moderately narrow at base; oval; inclining forward; well bent inward; of fine texture; in appearance waxy	1	
Neck	Long; fine and clean at juncture with the head; free from dewlap; evenly and smoothly joined to shoulders	4	
Shoulders	Slightly lower than hips; fine and even over tops; moderately broad and full at sides	3	
Chest	Of moderate depth and lowness; smooth and moderately full in the brisket; full in the foreflanks (or through the heart)	6	
Crops	Moderately full	2	
Chine	Straight; strong; broadly developed; with open vertebræ	6	
Barrel	Long; of wedge shape; well rounded; with large abdomen trimly held up; (in judging the last items age must be considered)	7	
Loin and Hips	Broad; level or nearly level between hook-bones; level and strong laterally; spreading from chine broadly and nearly level; hook-bones fairly prominent	6	
Rump	Long; high; broad; with roomy pelvis; nearly level laterally; comparatively full above the thurl; carried out straight to dropping of tail	6	

Scale of Points for Judging Holstein-Friesian Cows (continued)

Parts	Description	Possible Score	Student's Score
Thurl	High; broad	3	
Quarters	Deep; comparatively full	2	
Flank	Deep; comparatively full	2	
Legs	Comparatively short; lean and nearly straight; wide apart; firmly and squarely set under the body; feet of medium size, round, solid and deep	4	
Tail	Large at base; the setting well back; tapering finely to switch; the end ot the bone reaching to hock or below; the switch full	2	
Hair and Handling	Hair healthful in appearance; fine, soft and furry; skin of medium thickness and loose; mellow under the hand; the secretions oily, abundant and of a rich brown or yellow color	8	
Mammary Veins	Very large; very crooked (age must be taken into consideration in judging size and crookedness); entering very large or numerous orifices; double extension; with special developments such as branches, connections, etc.	10	
Udder and Teats	Very capacious; very flexible; quarters even; nearly filling the space in the rear below and extending well forward in front; broad and well held up	12	
Teats	Well formed; wide apart; plump and of convenient size	2	
Escutcheons	Largest; finest	2	
	Totals	100	

Scale of Points for Judging Holstein-Friesian Bulls

Parts	Description	Possible Score	Student's Score
Head	Showing full vigor; elegant in contour	2	
Forehead	Broad between the eyes; dishing	2	
Face	Of medium length; clean and trim, especially under the eyes; the bridge of the nose straight	2	
Muzzle	Broad with strong lips	1	
Ears	Of medium size; of fine texture; the hair plentiful and soft; the secretions oily and abundant	1	

Scale of Points for Judging Holstein-Friesian Bulls (continued)

Parts	Description	Possible Score	Student's Score
Eyes	Large; full; mild; bright	2	
Horns	Short; medium size at base; gradually diminishing towards tips; oval; inclining forward; moderately curved inward; of fine texture; in appearance waxy	1	
Neck	Long; finely crested (if the animal is mature); fine and clean at juncture with the head; nearly free from dewlap; strongly and smoothly joined to shoulders	5	
Shoulders	Of medium height; medium thickness; and smoothly rounded at tops; broad and full at sides; smooth over front	4	
Chest	Deep and low; well filled and smooth in the brisket; broad between the forearms; full in the foreflanks (or through the heart)	7	
Crops	Comparatively full; nearly level with the shoulders	4	
Chine	Strong; straight; broadly developed; with open vertebræ	6	
Barrel	Long; well rounded; with large abdomen; strongly and trimly held up	7	
Loin and Hips	Broad; level or nearly level between hook-bones; level and strong laterally; spreading out from chine broadly and nearly level; hook-bones fairly prominent	7	
Rump	Long; broad; high; nearly level laterally; comparatively full above the thurl; carried out straight to dropping of tail	7	
Thurl	High; broad	4	
Quarters	Deep; broad; straight behind; wide and full at sides; open in the twist	5	
Flanks	Deep; full	2	
Legs	Comparatively short; lean and nearly straight; wide apart; firmly and squarely set under the body; arms wide, strong and tapering; feet of medium size, round, solid and deep	5	

Scale of Points for Judging Holstein-Friesian Bulls (continued)

Parts	Description	Possible Score	Student's Score
Tail	Large at base; the setting well back; tapering finely to switch; the end of the bone reaching to hocks or below; the switch full	2	
Hair and Handling	Hair healthful in appearance; fine, soft and furry; skin of medium thickness and loose; mellow under the hand; the secretions oily, abundant and of a rich brown or yellow color	10	
Mammary Veins	Large; full; entering large orifices; double extension with special developments such as forks, branches, connections, etc.	10	
Rudimentary Teats	Large; well placed	2	
Escutcheons	Largest; finest	2	
	Total	100	

QUESTIONS

1. Where did the Holstein-Friesian breed originate?
2. Describe the soil and pasturing conditions of Holland.
3. Describe a Holstein-Friesian cow as to body and dairy characteristics.
4. What is the disposition of the Holstein?
5. What dairy characteristic is the most outstanding for this breed?
6. What cow and what breed now holds the world's record for butter fat production in a year?
7. In what four respects does Holstein milk differ from Jersey milk?
8. What can be said of the beef and veal quality of the Holstein?
9. When and by what people were Holland cows first brought to America?
10. When and where did the first to be kept pure arrive?
11. When was the first American association for the breed organized? What was it called?
12. When was the second association for the breed formed?
13. When did the two associations unite? What name was given to the breed?
14. How does the breed rank in point of number of dairy cattle in the United States?
15. Into what foreign countries have Holland cattle been taken?
16. What four or five places do Holland cows seem best fitted to fill?
17. When was official advanced registry begun?
18. How much butter fat must cows of various ages produce in a week to be admitted to advanced registry?

CHAPTER IX

GUERNSEYS

The Guernsey breed of cattle is one of comparatively recent recognition, not that animals of the present Guernsey characteristics have not been in existence for a considerable time, but rather that since their qualities and adaptations were so similar to those of the Jersey, the two breeds were, during a considerable part of the last century, considered as one breed and both in England and America were spoken of as "Alderney" cattle, from the group of Alderney or Channel Islands to which the islands of Jersey and Guernsey belong.

Origin.—The foundation stock for this breed was undoubtedly very similar to, if not practically identical with that used on the island of Jersey. Animals probably from Normandy and Brittany were, during a very early period, taken to the Island of Guernsey, which is the second largest of the Channel Island group. Here they have been bred for hundreds of years. During the earlier period it is highly probable that some mixing took place, especially with the animals from the Island of Jersey. But the interchange of animals between the two islands had to cease in one direction in 1763 when the residents of Jersey forbade the introduction of breeding stock, and in the other direction in 1819, since when animals on Guernsey Island have been kept pure, even from Jersey influence. In that year the Guernsey Islanders passed laws similar to those in operation in Jersey, prohibiting the importation of animals other than for slaughter (Fig. 21).

Although doubtless related particularly in respect to foundation stock, considerable difference now exists between the Guernsey and the Jersey. Professor Low, writing in 1841, seems to consider the cattle from the two islands as essentially one breed, yet goes on to describe those on Guernsey Island as larger and more highly marked with orange yellow skin, and as yielding a

somewhat more yellow milk and butter. More recent investigations strongly support the theory that at some period several hundred years ago animals which were the true descendants of the "spotted cattle" or Simmenthaler, of Switzerland, had been introduced as breeding stock on the Island of Guernsey. Not only is this supported by the larger size, quieter disposition, and more yellow secretions of the Guernsey, but also from the fact that there are at present animals possessing characteristics similar to the Guernsey and Simmenthaler on either side of the

Fig. 21.—May King of Linda Vista, recently sold for the highest price ever paid for an animal of the Guernsey breed. (Courtesy Jean Du Luth Farm, Duluth, Minn.)

Rhine River, from its source in the Alps to its mouth in the North Sea. Much of the stock through this valley is frequently spoken of as red or red and white, but it is recognized by the careful observer that the so-called red is not the deep cherry red of the Shorthorn and Hereford, but rather an orange red. It is most natural to believe that as the people crossed the mountains and followed the river northward they took their patient and highly prized animal servants with them. It would then be but a short voyage to Guernsey Island which lies so handily in the channel. The exact facts may never be known, however.

Although the Guernseys were taken at an early date to England they were used largely by the nobility, the same as were the Jerseys. They are now increasing rapidly in popularity in the United States. They are not to be found in any considerable number on the continent of Europe or in foreign countries.

Home Conditions.—Guernsey Island comprises only 16,000 acres, of which approximately 12,000 acres are tillable, the southern end of the island being a high cliff. This island rises

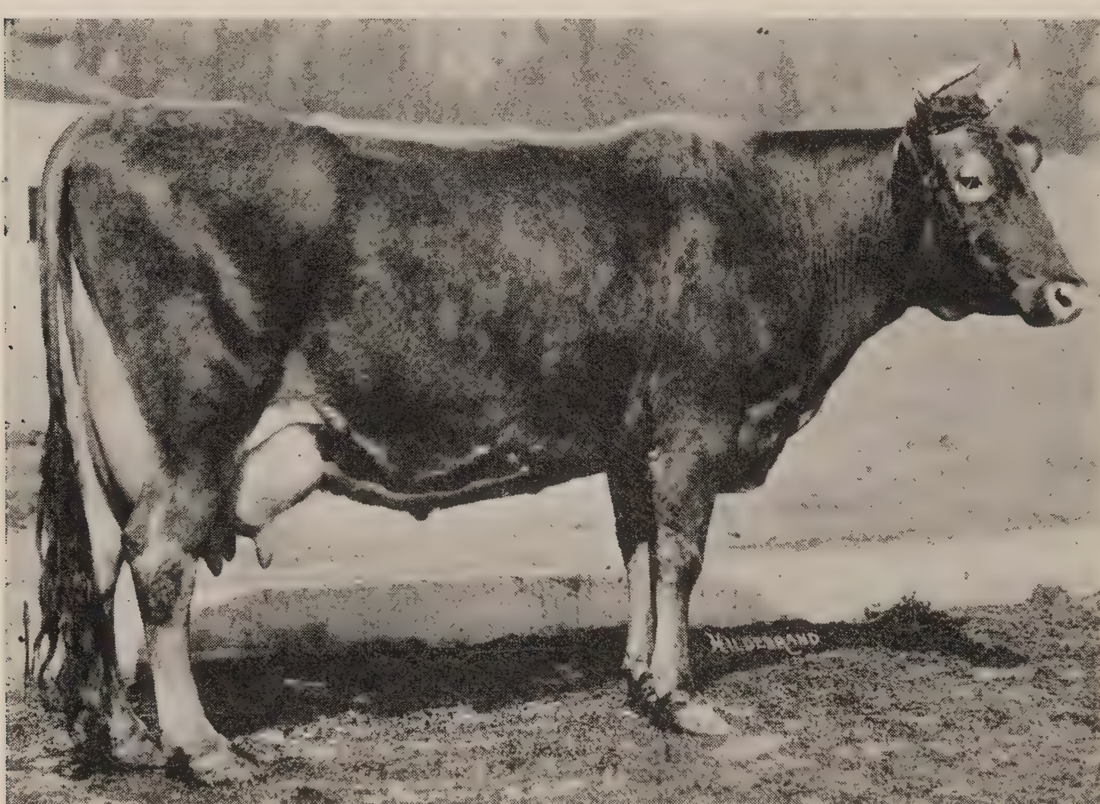

Fig. 22.—Guernsey cow, Murne Cowen. Record for one year, 24,008.4 pounds milk containing 1098.18 pounds fat. Owned by Anna Dean Farm, Akron, Ohio.

abruptly out of the ocean to a height of nearly 300 feet and slopes away northward for a distance of ten miles. The system of agriculture here must be adapted to the comparatively cooler soil of the north slope, where grass and vegetation tend to grow less rapidly but to larger size and greater succulence. It is possible that this has had something to do with the larger size of the 8000 cattle kept on the island (Fig. 22). Truck gardening with a liberal use of green houses for the supply of fresh vege-

tables to the English market comprises a large part of the crop-growing business.

Introduction to America.—In 1818, 1825 and 1830, animals known as Alderneys were brought to Pennsylvania. They were probably imported from England. Whether these were Jerseys or Guernseys will probably never be known. They were known as Alderneys. The first importation to be kept pure arrived in this country in 1850. Most of the importations were made from 1880 to 1890, or since 1900. The interests

Fig. 23.—Robinna's Standard, Guernsey bull, bred by Gov. W. D. Hoard, Fort Atkinson, Wis.

of the breed in America are looked after by the American Guernsey Cattle Club, which was organized in 1877. This organization was essentially a splitting away from the American Jersey Cattle Club, which, previous to this time, had been admitting animals of either breed to registry. Over 50,000 animals have now been registered, of which about one-third have been bulls. The distribution of Guernseys in America has been largely in the northern states, few going south, and fewer still going into Canada. Massachusetts, New York, and Pennsylvania in the east, and Wisconsin and Minnesota in the

FIG. 24.—Guernsey young herd. Prize winners at Minnesota State Fair. Note thrift and poise, also variation in color marking which is common in the breed. Owned by Jean Du Luth Farm, Duluth, Minn.

middle west, are the states chiefly interested in this breed. Wisconsin may be said to be the western center, though Minnesota is gradually becoming a rival for this honor (Figs. 23 and 24).

Body Characteristics.—Guernsey cows should weigh, when mature, between 1050 and 1250 pounds, and bulls from 1700 to 2000 pounds. Considerable variation in size now exists, however, due partly to the recent admission into this country, and their registration as Guernseys, of the cattle which for centuries have been raised on the third largest of the Channel Islands, namely, Alderney. For some reason the mature cattle of Alderney Island are not as large even as the Jersey and fall very far short of matching the ideal Guernsey. There are many who believe that it was a serious blunder to admit into America these small cattle, especially to admit them in the name of a much larger breed. Many breeders and practical dairy farmers, who have chosen Guernseys over Jerseys, have done so because of the reputed greater size of the former. The Guernsey naturally carries a little more flesh than the Jersey and is not so sensitive to the cold. To reduce the scale of the animals now is to throw them into the Jersey class in this respect where they will probably be easily equalled as efficient dairy animals by Jerseys of their own size. The color of the Guernsey is orange-yellow and white, in large patches. The shade of the yellow varies from light to a near red. Neither extreme is desirable. The temperament of the Guernsey is particularly agreeable. She is intelligent, but not so nervous, not so affectionate nor so resentful as the Jersey. Neither is she so indifferent as the "cold blooded" Holstein. Her sunny disposition and easy handling habits have won her many friends. There is a tendency, however, for individuals and families of this breed to lay on fat too readily.

Calves at birth should weigh from sixty to eighty pounds and are inclined to be somewhat delicate. They are not as easily reared as the young of either the Holstein or the Ayrshire breed. Heifers mature rapidly and unless care is taken are liable to begin milking too early for best growth.

Dairy Characteristics.—The Guernsey is outstandingly a dairy breed. While some members of them carry considerable flesh and fatten at a sufficiently good rate, they, in common with other dairy breeds, do not place the gain either in the place or in the condition to be most highly valuable. Their beef-making qualities are entirely secondary. As a whole, the cows of this breed yield rather more milk than the Jerseys, but it does not

FIG. 25.—Dairy Maid of Pinehurst, Guernsey cow that, at four years of age, produced in one year 17,285.3 pounds of milk which contained 910.67 pounds butter fat. Note deep body, well-balanced udder and large milk vein, also the evidence of good care. Owned by W. W. Marsh, Waterloo, Iowa.

test quite as high. A yield of 6000 to 9000 pounds of milk per year is not at all unusual, while the percentage of fat ranges close to five. Comparing their yield with the Holstein, they give much less milk, but it tests more. In respect to their milking habits as in other points the Guernsey occupies a position between the Jersey and the Holstein, but rather more near the Jersey. One value of Guernsey milk is its exceedingly yellow color. In this respect, it outclasses all other breeds. Not infrequently butter made from Guernseys on full grass pasture is

more highly colored than some markets desire. On the other hand, a few animals of Guernsey blood in a herd of Holsteins quite naturally increase the color as well as the fat content and enhance its selling qualities. The length of the lactation period of this breed varies with the intensity of dairy temperament and with their feed and handling, as with other breeds.

Adaptations.—There are a few places where the qualities of the Guernsey are particularly needed. She fills rather better than any other dairy breed, the needs of those small farmers who do most of their own work and who have but a moderate quantity of feed to use. Their problem is how to convert a moderate-sized hay stack and other material into a product which will bring the most money. Next to the Jersey the Guernsey converts the largest proportionate amount of her feed into milk fat (Fig. 25), but since the modern Jersey is rather sensitive for general farm life in the northwestern sections of the United States, the Guernsey is being largely adopted as her substitute. A second peculiar place is, as mentioned, in the herds of some of the breeds producing a very white milk for market.

Advanced Registry.—In 1901 a system of advanced registry was adopted and though the test period at first covered either seven days or a year the rules were soon changed to recognize only the full year test. Records included both the pounds of milk yielded and the fat produced as measured by the Babcock test. "The owner of the cow keeps the milk records in detail throughout the year." Once every month an official representative of an experiment station or agricultural college visits the farm to confirm the yields recorded by the owner and to test the milk produced at that time. A two-year-old cow will not be admitted into advanced registry unless she produces 6000 pounds of milk and 250 pounds of fat. Older cows are required to produce 3.65 pounds of milk per day more, up to five years of age, and for each day past two years of age at the time of beginning, one-tenth of a pound of fat additional is required. Mature cows are admitted upon the production of 360 pounds of fat per year. Bulls are admitted to advanced registry when two or more of their daughters have been admitted.

It was the record made by the Guernsey cows at the World's Fair in Chicago, in 1893, which first attracted the attention of the American farmer to this breed, and the record of the cow Mary Marshall, when she led a herd of 50 cows of 10 breeds at the model dairy at the Pan-American Exposition in 1901, that fixed it. Since that time many handsome records have been made by members of this breed. Particularly to be noted is the record recently made by the cow, May Rilma (Fig. 2), in producing in 365 days, 19,630.5 pounds of milk which contained 1059.59 pounds of fat, equivalent to 1271.5 pounds of butter estimated upon the basis of 80 per cent fat. And later the cow Murne Cowan produced in one year, 24,008 pounds of milk containing 1098.18 pounds of fat, equivalent to 1317.82 pounds of butter. These records established for this breed the world's championship in butter production—held for about a year.

The following are the best official yearly records made up to October 1, 1915, by this breed:

Class A—5 Years and Over

	Age	Pounds Milk	Pounds B.F.	Per cent B.F.
Murne Cowan 19597, A. R. 1906, Re-entry	8 yr. 9 mo.	24008.00	1098.18	4.57
May Rilma 22761, A. R. 1726, Re-entry	6 yr. 4 mo.	19673.00	1073.41	5.46
Spotswood Daisy Pearl 17696, A. R. 790, Re-entry	7 yr. 5 mo.	18602.80	957.38	5.15
Julie of the Chene, 30460, A. R. 2752, Re-entry	6 yr. 1 mo.	17661.00	953.53	5.40
Imp. Daisy Moon III 28471, A. R. 1909 Re-entry	6 yr. 4 mo.	18019.40	928.39	5.15

Class B—4½ to 5 Years

	Age	Pounds Milk	Pounds B.F.	Per cent B.F.
Dairymaid of Pinehurst 24656, A. R. 843 Re-entry	4 yr. 8 mo.	17285.30	910.67	5.27
Julie of the Chene 30460, A. R. 2752	4 yr. 10 mo.	15174.20	827.26	5.45
Lady Lesbia 25142, A. R. 1348 Re-entry	4 yr. 10 mo.	13582.75	787.03	5.79
Pandora's Valentine of Rich Neck 27622, A. R. 1742, Re-entry	4 yr. 9 mo.	14341.60	784.22	5.87
Glenanaar of the Glen 23619, A. R. 1907	4 yr. 7 mo.	16813.10	780.66	4.64

Summary of 4298 Advanced Register Records

			Milk	Pounds B.F.	Per cent B.F.
Class A.	1275	Cows Average	10065.47	494.91	4.916
Class B.	230	Cows Average	9609.24	480.22	4.997
Class C.	337	Cows Average	9103.39	457.34	5.023
Class D.	338	Cows Average	8869.44	445.85	5.026
Class E.	445	Cows Average	8220.14	416.75	5.069
Class F.	533	Cows Average	7902.34	400.95	5.073
Class G.	1140	Cows Average	7579.28	379.55	5.007
Av. for	4298	Cows	8752.82	436.98	4.992

Scale of Points for Judging Guernsey Bulls

Scale of points	Counts	Student's Score
Dairy Temperament, Constitution—38.		
Face, lean, clean cut		
Jaw, strong, sinewy		
Muzzle, wide, open nostrils		
Eyes, full bright, with quiet gentle expression		
Forehead, long, broad	5	
Neck, masculine, with strong juncture to head		
Throat, clean		
Backbone, rising well between shoulders		
Spinal processes, large, rugged	5	
Pelvis, wide, arching		
Rump, long		
Spine, wide, strong at tail head		
Tail, long, thin, full switch		
Thighs, thin, incurving	5	
Ribs, amply and fully sprung, wide apart		
Flanks, thin, arching	5	
Abdomen, large, deep, with strong muscular and navel development	15	
Hide, firm, yet loose, oily feeling and texture, but not thick	3	
Dairy Prepotency—15.		
Vigor, alertness, style and resolute appearance...........	15	
Rudimentaries and Milk Veins—10.		
Rudimentaries, large squarely and broadly placed in front of and free from scrotum		
Milk veins, prominent	10	
Color of Product—15.		
Skin, deep yellow in ear, end of tail, base of horns, and body generally		
Hoofs, amber colored	15	

Scale of Points for Judging Guernsey Bulls (continued)

Scale of points	Counts	Student's Score
Symmetry and Size—22.		
Hair, a shade of fawn with white markings		
Nose, cream colored		
Horns, amber colored, light, curving and not coarse	8	
Size for the breed, mature bulls about 1500 pounds	4	
General appearance, as indicative of the power to beget offspring with strong dairy qualities	10	
Total	100	

Scale of Points for Judging a Guernsey Cow

Scale of Points	Counts	Student's Score
Dairy Temperament, Constitution—38.		
Face, lean, clean cut		
Jaw, strong, sinewy		
Muzzle, wide, open nostrils		
Eyes, full, bright, with quiet gentle expression		
Forehead, long, broad	5	
Neck, long, thin, with strong juncture to head		
Throat, clean		
Backbone, rising well between shoulders		
Spinal processes, large, rugged	5	
Pelvis, wide, arching		
Rump, long		
Spine, wide, strong at tail head		
Tail, long, thin, full switch		
Thighs, thin, incurving	5	
Ribs, amply and fully sprung, wide apart		
Flanks, thin, arching	5	
Abdomen, large, deep, with strong muscular and navel development	15	
Hide, firm, yet loose, oily feeling and texture, but not thick	3	
Milking Marks, Flow—10		
Escutcheon, high, broad, wide on thighs with high ovals	2	
Milk veins, long, crooked, prominent, branching with capacious wells	8	
Udder Formation—26.		
Udder, full in front	8	
Udder, full and well up behind	8	
Udder, large, capacious	4	
Teats, well apart, squarely placed, of good and even size	6	
Color of Product—15.		
Skin, deep yellow in ear, end of tail, base of horns, udder, teats, and body generally, amber color hoofs	15	

Scale of Points for Judging a Guernsey Cow (continued)

Scale of points	Counts	Student's Score
Quality of Milk—6.		
Udder, showing plenty of substance, but not too meaty.....	6	
Symmetry and Size—5.		
Hair, a shade of fawn with white markings		
Nose, cream colored		
Horns, amber colored, light curving	3	
Size for the breed, mature cows about 1050 pounds........	2	
Total	100	

QUESTIONS

1. Under what name were Guernsey cattle known when introduced into England and America? Why?
2. What stock probably furnished the foundation for Guernsey blood?
3. What blood element probably was introduced into Guernsey Island but not into Jersey Island?
4. Trace the Rhine River from Switzerland to the North Sea.
5. Locate the Channel Islands, Guernsey Island. How large is it compared with the county in which you live?
6. What is the color of a well marked Guernsey? What undesirable color occasionally crops out? What should be done with such animals?
7. How large is an ideal Guernsey cow? Bull?
8. What is the disposition of a Guernsey cow?
9. What should be looked for in the matter of calves?
10. How much milk and what percentage of fat ought a Guernsey cow to yield?
11. Compare milk yield and fat grade with Holsteins and Jerseys.
12. What may be said regarding the color of Guernseys' milk and butter?
13. What seem to be the particular places into which the Guernsey cow fits?
14. When and how were Guernseys introduced into America?
15. What states are now most interested in them ?
16. When and under what conditions was the advanced registry adopted for this breed?
17. What are the milk and fat requirement for admission into the advanced registry?
18. Name the cows having the five highest records.
19. How much did each produce?
20. What is the record in milk and fat and percentage of fat of the average of all the advanced registry cows?

CHAPTER X

THE JERSEY

THE Jersey is the most refined present representative of the race of cattle which developed in southern Europe. She is probably related very distantly to the ancient stock of Switzerland. As agricultural development moved northward it is highly probable that the animals common in the south were taken northward to form the stock of ancient Normandy and Brittany, and that these in turn were the source of the stock for Jersey Island, which place became the home of the breed that bears its name. Little exact information is obtainable regarding the manner of handling or the characteristics of the early ancestors of the Jersey breed.

Home Conditions.—Off the north coast of France, in the English Channel, there is a little group of islands known as the Channel Islands. In order of size, they are Jersey, Guernsey, Alderney, and Sark. These belonged to Normandy before the Conquest of England when William the Conqueror, in 1065, made his famous invasion. The sovereignty over the islands fell to the people who later developed the British Empire. Thus we find that the islands, which lie so close to the French coast and are peopled largely by folk of French characteristics and with the French language, still owe allegiance to England. Their affiliation, however, is unique and permits of certain liberties in respect to self-government which are enjoyed by few of the provinces.

In 1763 and again in 1789 laws were passed in Jersey Island prohibiting the importation of cattle except for slaughter. The law has been modified slightly a few times since, but has been in force, and been enforced for more than a century and a half since, and is still looked upon as an exceedingly valuable law. It was done to safeguard the health of the cattle on the island, but has been of even greater value in preserving the purity of blood and permitting the development of one of the most valuable breeds of cattle in the world.

The island itself is only eleven miles long, by nine miles wide. It has a total area of about 39,500 acres, of which 25,000 are tillable. The population of 60,000 is engaged largely in truck gardening, making a specialty of early potatoes. The cow, however, has been given much attention and is an important source of revenue. There are about 10,000 cows on the island, or one for every two and one-half acres of cultivated land.

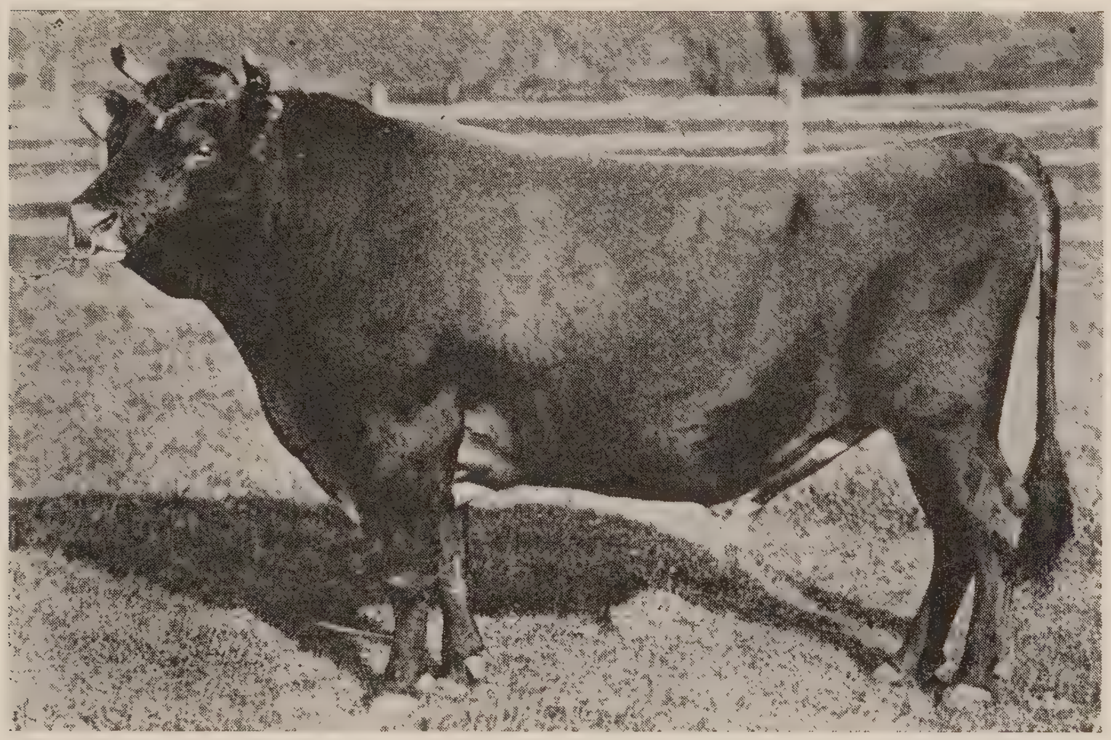

Fig. 26.—Imp. Oxford Majesty. A champion both on Jersey Island and in America. Note strong back, rugged build yet a conformity to the dairy type. (Owned by White Horse Farms, Paoli, Pa.)

IMPROVEMENT FROM WITHIN

Early writers on agricultural topics mention the cows of the island as being very ununiform in every respect; some very beefy; some were flat and with but poor constitutions, while yet others were fairly symmetrical dairy cows.

It is evident, however, that the essential merit of the stock was recognized, since improvement was sought by selection within the blood rather than by introduction of such outside elements as were obtainable on the continent (Fig. 26).

Systematic improvement began in 1834 when a score card

was adopted to be used at the second annual fair held by Jersey Royal Agricultural and Horticultural Society. This is the first record of the application of the score card system in judging. The scale of points has been modified from time to time, but has served well to bring about uniformity and refinement combined with useful characteristics.

The plan of registration on the island is unique. "Cows are registered as pedigree stock and foundation stock; bulls as pedigree stock only." Within twenty-four hours after a cow drops a calf the owner must notify a representative of the Department of Agriculture, who must satisfy himself that the calf in question was actually born from the cow claimed by the owner to be its mother. A certificate is then issued showing the birth of the calf. This certificate, together with one from the owner of the sire of the calf, is then filed with the secretary or the registrar. This is called preliminary registration. Examinations are frequently held for the qualifications of these registered cattle. If the young animals are growing into form such as to indicate future high quality they are passed as "commended" or "highly commended," and those commended animals are at two years of age entered in full registry under the number and name by which they may be imported to America and transferred to the American Jersey Cattle registry. Rejected animals may be entered in examination later and, if satisfactory, be approved.

In the case of males, the dam must be shown and her qualities are taken together with those of the little bull, and he is either rejected or passed, according to quality of both (Fig. 27). An individual breeder is not compelled to use fully registered sires, but the pressure has been so strong that most of them have complied with the judgment of the committee of five; have disposed of the rejected animals; and bred to the approved. This system has certainly developed a wonderfully uniform and beautiful breed. On the island little attention was paid to the making of butter records, further than one day tests at fairs, until 1912, when milk and butter record keeping, very much as the Registry of Merit in America, was instituted.

The animal has meant much in the development of Jersey Island, and is still a potent factor in its industrial affairs. The Jersey, like the Holstein cow, is pastured at the end of a long rope. The forage in Jersey, however, is more scanty and richer in character than it is in Holland. This may be due to the fact that the island is raised nicely above sea level and that the north side is considerably higher and more abrupt than the southern, thus forming a southern slope which warms very rapidly in the direct rays of the sun. The Jersey at home is a

Fig. 27.—The champion Jersey bull, Nobles Eminent Lad. (Owned by E. C. Lasater, Talfurries, Texas.)

pet, is handled very largely by the women, and is carefully fed on grass, parsnips, carrots, and odds and ends from the garden. Comparatively small amounts of grain are fed.

Body Characteristics.—The color of the Jersey is not looked upon as an essential feature of the breed. Consequently, variation is found. Some are of a creamy white, while a few are found that have large yellow or orange spots in a field of white, quite similar to the Guernseys. The majority, especially in America, have almost solid color of varying shades, from a light

silvery gray or fawn, through various shades of rich red, to a seal brown, almost black. In size the Jersey is one of the smallest of the dairy breeds (Fig. 28). Mature cows should weigh in the neighborhood of 900 pounds, while the bulls may vary between 1300 and 1700. The Jersey calf at birth weighs from 50 to 80 pounds, and though healthy, is quite a baby to raise. The Jersey heifer matures at a very early age. Care must be taken to prevent too early breeding. The fact that they will breed early is sometimes an advantage, however, in that there is a shorter period of unprofitable feeding. The intelligence of the Jersey cow is remarkable, and her affectionate qualities endear her to those who love stock. This same quality, however, is a disadvantage when she is in the hands of one who is rough or boisterous, or generally unfriendly. When roughly handled the Jersey is more likely to resent the treatment than a cow of less sensitive organization. Thus we have conspicuous examples of cows which did exceedingly poorly under one management that proved to be wonderful producers in the hands of another.

Dairy Characteristics.—The Jersey is the most highly specialized dairy cow in America. She is not conspicuous for the quantity of milk (Fig. 28), but rather for the rich quality of it. The average fat test of the milk of this breed is not far from five and one-half per cent, while many individuals produce milk with as high as six and even seven per cent fat. During the earlier days of dairying the Jersey was known as the cow for the "butter dairy." Her milk was so rich that only sixteen to nineteen pounds would be required to make a pound of butter, whereas twenty-five or more pounds of the milk of other breeds would be required to equal it. Not only is it rich in fat, but the globules are comparatively large in size. This fact facilitates quick and thorough creaming by gravity. There will be less fat washed in the skim milk, under the old system, with a Jersey than with breeds yielding smaller fat globules. The condition still remains but its importance is now negligible when the centrifugal cream separator is used. The milk of the Jersey produces cheese of very rich quality, even more fatty than the

trade generally cares to pay for. A small quantity, however, added to the milk of the Holstein has a marked improving effect in either cheese or market milk. The fact that the globules of fat are one-nine-thousandth of an inch in diameter instead of one-twelve-thousandth of an inch need not deter any one from choosing such milk as an infant food. The percentage and total quantity of fat fed a child is so much more important than the

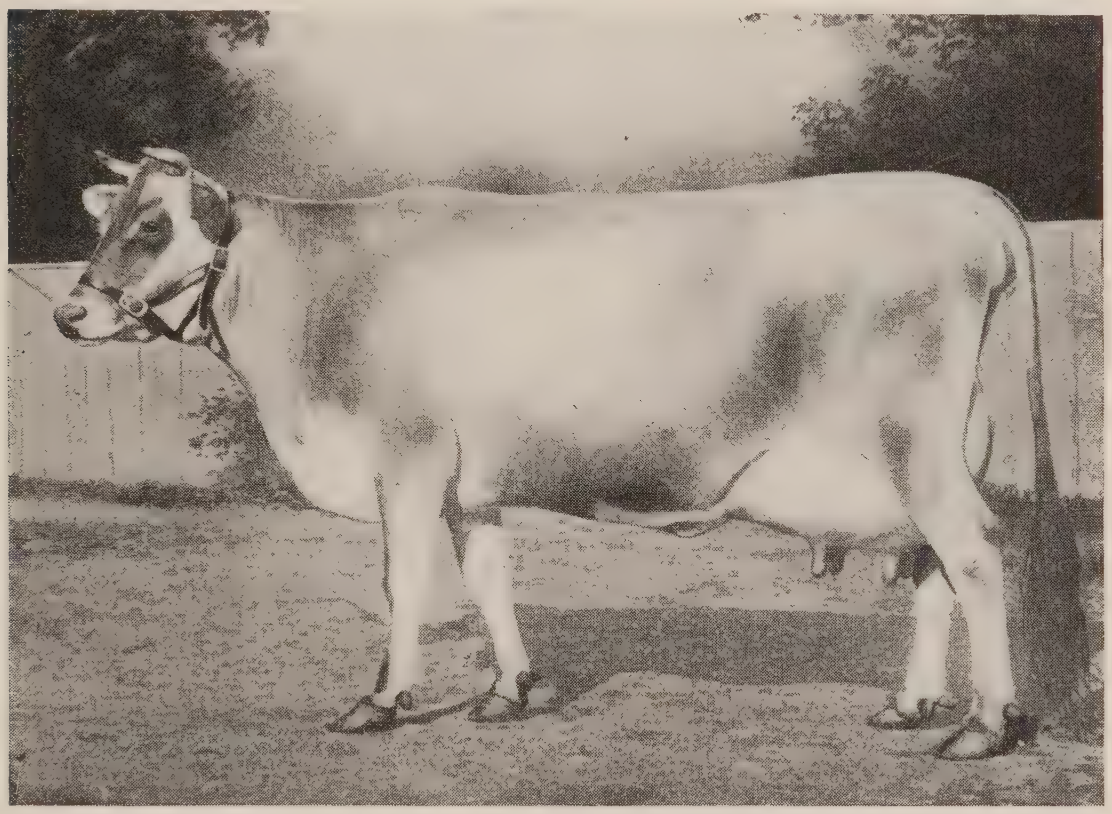

Fig. 28.—Sophie 19th, of Hood Farm. The champion Jersey cow of the world in butter fat production. She produced in one year 17,557 pounds 12 ounces of milk which contained 999 pounds 2.2 ounces of butter fat. Note deep body and well-balanced udder. (Owned by C. I. Hood, Lowell, Mass.)

size of the fat globule that the size may generally be neglected entirely. (See chapter on Holsteins for more of this.)

Introduction to America.—Jersey and Guernsey cattle were taken to England at an early date and there known as Alderney cattle, since they had come from the Alderney or Channel group of islands. As early as 1815 cows were imported from the Island of Alderney, and in 1818, and again in 1825, animals of this blood were brought to America, either from England or, less likely, from the Islands. These animals were known as Alder-

neys, but their blood was not kept pure. They furnished the foundation stock, however, for much of the region in the southern states. In 1851 a few Jerseys were imported into Massachusetts and in 1868 a few animals were brought to Montreal, Canada. From these importations have descended many of the most famous producers in this country. From about 1870 to 1890 importations were numerous, then for a period few were brought over. At the present time there are several important annual importations. The interests of the breed in America are looked after by the American Jersey Cattle Club. It was formed in 1868. There have now been registered in America about 300,000 Jerseys, of which one-quarter were bulls. Jerseys are now to be found in every state (Fig. 30) and in practically every county of most of the states. The Jersey has also been introduced into most of the civilized countries, but is most popular in England and America.

Island Versus American Type.—It was comparatively early in the improvement of the Jersey breed that representatives were first imported to America. These were for the most part handled by practical lovers of the breed. Descendants from these early importations have been formed into a more or less well-defined type usually spoken of as the "American type," because developed in this country. These cows are comparatively large, straight, almost coarse, and decidedly plain, compared with the present highly finished animal of the island. The majority of the high records for production in this country are held by representatives of the so-called American type. The island type of Jersey is 100 to 200 pounds lighter in weight; very much more refined in texture and feature, and is now marked by having a comparatively short head with dished face. These animals are more symmetrical than those of older American breeding, not only in top line, but also in udder development. While many of the large records are held by the American type it does not in itself prove that this type is essentially more productive or economical. Animals of recent importation have gone more largely into the herds of wealthy owners who in the past were not primarily interested in large milk records or economy of milk pro-

Fig. 29.—Financial Daisy. A champion Jersey cow. Note deep body, well-balanced udder, tortuous milk veins. (Owned by White Horse Farm, Paoli, Pa.)

Fig. 30.—Bright Princess Jolly Girl. A prize-winning Jersey cow belonging to Geo. T. Slade, St. Paul, Minn.

duction. This has left the field comparatively open to the smaller owner who is more likely to be a practical milk producer. There are likewise a larger number of the American type of animals available for contest purposes (Fig. 29).

Extremes of these two types are almost, if not quite, as far apart in character as are the modern Jersey and the refined Guernsey. Certain it is that the extremes of the two types should not usually be mated, for the same reason that the Jersey and the Holstein should seldom be crossed. They are too unlike.

While the American type is thought to be possessed of greater constitution than the more highly refined island type, one must be careful that hasty conclusions are not drawn in the matter.

Constitution a Relative Term.—Constitution is the ability of the animal to do its life work. Constitution is, in part, the relation between the power of the heart of the animal to pump blood throughout its system and the power of its lungs to purify the blood, compared to the resistance which the blood is to meet in coursing through the body. A large strong heart working against a body filled with fat might be strained far more than a heart of only two-thirds the actual power working in a body where the arteries are not closely surrounded by fat but are elastic and can expand with every throb. With this view of the matter we are not surprised to see the angular little Jersey working nervily and profitably until 16 and even 20 years of age. This matter is even better illustrated in the case of horses. The large, well-rounded horse is often outclassed at continued hard work by one of a thinner, nervier make-up.

Beef Characteristics.—This breed has never made any claim to true beef-making qualities, nor even yet has there been any tendency to make of it a so-called dual purpose breed. Generations of selecting for dairy purposes have produced in the Jersey an animal wonderfully well adapted to milk production. It will fatten readily enough, but does not place the gain where it will be most valuable, nor yet is the meat of quite so high quality as that produced by a breed which has for generations been trained for beef production. The fat of Jersey beef is likely to be rather

too highly colored for most trade, and is placed in patches and layers outside of the muscle rather than being finely distributed through the tissue as in the case of high-type beef animals. To consider the Jersey cow as worthless for beef, however, is incorrect.

Adaptations.—As a breed the Jersey will produce butter fat more cheaply per pound than any other breed. This is due to several conditions.

First, she will consume more feed in proportion to her size than will the larger breeds.

Second, the solid matter of her milk carries a much higher percentage of fat and a less proportion of non-fat. When butter fat is worth in the neighborhood of thirty cents a pound, the sugar and casein of milk are worth four and a half to six cents a pound. Naturally, therefore, that animal which converts her feed into a substance with a higher percentage of the more valuable materials will have the advantage over one which produces so much cheap milk solids. This being the case, we must expect that on systematic dairy farms where the production of butter or cream is the first aim of the dairy and where kindness and comfortable care can be assured, the Jersey cow will be found rather more profitable than some other breeds.

Third, the Jersey is particularly well adapted to meet the climatic and feed conditions of our southern states, the common stock of which is already largely of the Jersey blood. It would seem that she might well become the common cow for the southern farmer, although the small size of the Jersey need not deter the northern dairyman from keeping her, for good buildings can make summer temperatures at any season.

A fourth place for the Jersey is as a town cow. She consumes less total feed, occupies less space than other breeds, and yields enough milk, and that of the highest quality.

Improvements Needed.—Aside from the common imperfection of form, such as sloping rump (Fig. 31), and of function, such as being occasionally only moderately valuable as dairy animals, the present status of the Jersey is important, especially because of the two more or less well defined but radically differ-

ent types of pure bred, registered Jerseys on the market, the crossing of which is liable to produce very unsymmetrical and otherwise undesirable animals. Relief from the situation cannot well take place until the breeders settle upon some type and size as the goal toward which to select and breed. At present some Jersey breeders contend for a small, beautiful animal and others for a larger, less nervous, even though coarser, beast. This inability to get together on the matter has prevented the extension

Fig. 31.—A poor rump and fore udder but a good producer for all that. Rosalind of Old Basing.

of the Jersey to as wide a field as might otherwise have been claimed by it.

Testing System.—In 1884 the system of making seven-day tests was inaugurated for the Jerseys. These were made in private, and later oath was taken as to correctness. Mature cows producing fourteen pounds or more of butter per week were found and said, thereafter, to be in the fourteen-pound list. These private records, like those reported for the Holstein cows

during the earlier days of the breed in this country, were probably correct, but people naturally had little confidence in them. In 1903 the "Register of Merit" was established and the rules so changed as to require a verification of the yield, by means of the Babcock test. The advanced records of Jerseys are now being supervised by representatives of the Agricultural College or Experiment Stations of the various states and, like the records of the advanced registry of the Holstein and Guernsey, are as

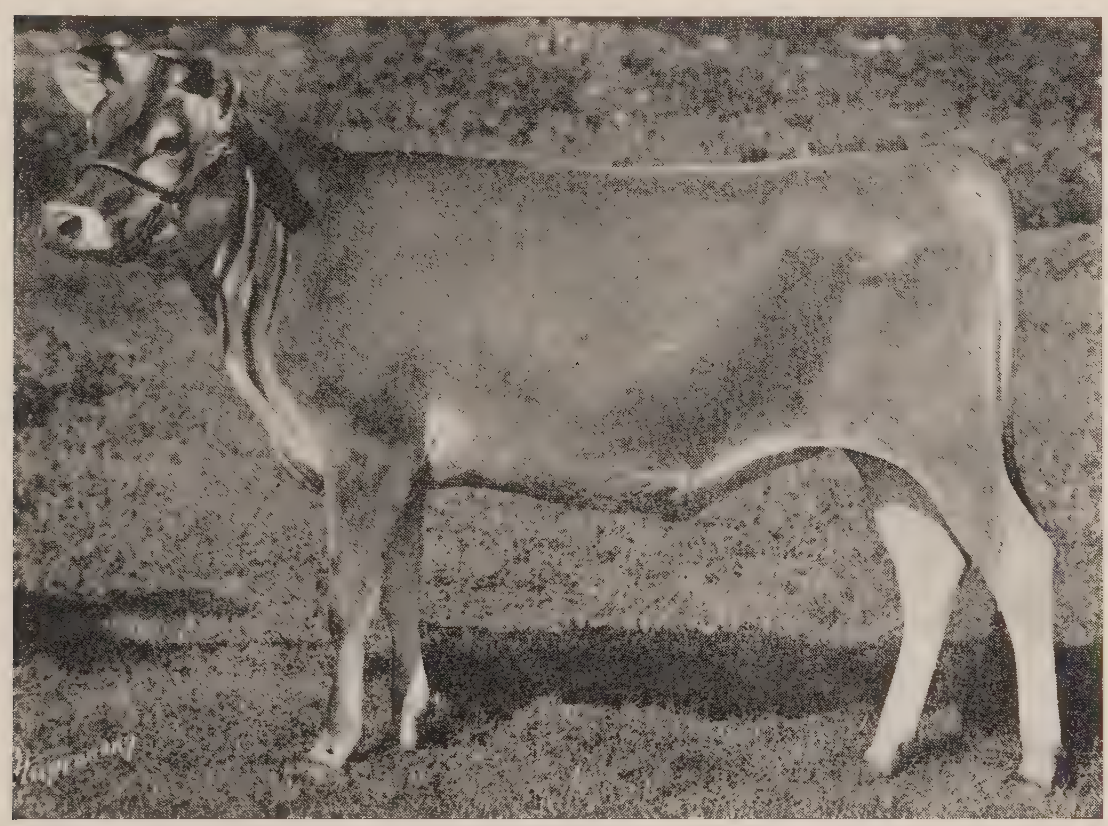

Fig. 32.—A champion Jersey heifer, eighteen months old. Cupid's Noble Fontaine. (Owned by Geo. T. Slade, St. Paul, Minn.)

nearly correct and free from error as can well be made. The Jersey requirements for registry of merit are the same as the Guernsey.

Records.—Although the Jersey has been perfected until she is a beautiful and affectionate animal, her production has not been overlooked. As a breed the Jersey is a wonderfully economical and constant producer (Fig. 32).

"The records of other breeds than the Jersey are sometimes computed on the basis of butter eighty per cent fat, instead of

eighty-five per cent. Eighty per cent fat is the legal standard of butter in the states of California, Colorado, Iowa, Kansas, New Hampshire, Ohio, South Dakota and Utah. For the purposes of comparison with claims made on behalf of cows of other breeds, a list of the Jersey pacemakers is appended hereto with yields computed on the basis of eighty per cent fat in the butter."

Thousand-pound Jersey Records

Name of cow	Milk Lbs.	Oz.	Fat Lbs.	Oz.	80% butter Lbs.	Oz.
Sophie 19th of Hood Farm (189748) ..	17557	12	999	2.2	1246	3
Spermfield Owl's Eva (193934)	16457	6.4	993	4	1241	8
Eminent's Bess (209719)	18782	15.6	962	13.2	1203	8
Jacoba Irene (146443)	17253	3.2	952	15.4	1191	3
Olympia's Fern (252060)	16147	13.6	937	13.3	1172	4
Sophie 19th of Hood Farm (189748) ..	15099	6	931	15.5	1164	11
Lass 66th of Hood Farm (271896)	17793	11	910	10	1138	4
Lass 38th of Hood Farm (223628)	15284	....	890	6.0	1112	15
Temisia's Owl's Rose (215973)	17056	7	863	12	1079	11
Lass 40th of Hood Farm (223642)	18661	7	854	14.9	1068	11
Sophie 19th of Hood Farm (189748) ..	14373	3	854	13.7	1068	9
Olga 4th's Pride (160791)	16275	13.2	851	11.7	1064	11
Adelaide of Beechlands (168699)	15572	1.6	849	9.9	1062	..
Rosaire's Olga 4th's Pride (179509) ..	14104	13.6	836	15.8	1046	3
Golden Angela (225625)	12795	10	829	4	1036	10
Warder's Lady (195777)	14820	11	819	15	1024	14
Rosalind of Old Basing (193202)	15734	12.8	816	1.6	1020	2
Pearly Exile St. Lambert (205101) ...	12345	8	816	1.27	1020	1
St. Mawes Poppy (219992)	12934	4.8	800	13.5	1001	1

It should be observed that although the quantity of milk yielded is far less than is shown in an earlier chapter for Holsteins, the quantity of butter fat far more nearly approaches the production of the other breed. Neither is the total quantity produced the criterion, since the cost of production is quite as important as the yield. The Jersey may be said to be the converse of the Holstein in the matter of milk production. The Jersey produces a comparatively small quantity of the richest milk, while the Holstein produces the largest amount of comparatively "lean" milk.

Scale of Points.—The scale of points for cows now in use for the perfecting of the breed was adopted in 1915 and follows:

Scale of Points for Judging the Jersey Cow

	Counts	Student's Score
Dairy Temperament and Constitution.		
Head 7:		
A—Medium size, lean; face dished; broad between the eyes; horns medium size incurving	3	
B—Eyes full and placid; ears medium size, fine, carried alert; muzzle broad, with wide open nostrils and muscular lips; jaw strong	4	
Neck 4:		
Thin, rather long, with clean throat, neatly joined to head and shoulders	4	
Body 37:		
A—Shoulders light, good distance through from point to point, but thin at withers; chest deep and full between and just back of forelegs	5	
B—Ribs amply sprung and wide apart, giving wedge shape, with deep, large abdomen, firmly held up, with strong muscular development	10	
C—Back straight and strong, with prominent spinal processes; loins broad and strong	5	
D—Rump long to tail-setting and level from hip-bones to rump bones	6	
E—Hip bones high and wide apart	3	
F—Thighs flat and wide apart, giving ample room for udder	3	
G—Legs proportionate to size and of fine quality, well apart, with good feet and not to weave or cross in walking	2	
H—Hide loose and mellow	2	
I—Tail thin, long, with good switch, not coarse at setting-on	1	
Mammary Development		
Udder 26:		
A—Large, flexible and not fleshy	6	
B—Broad, level or spherical, not deeply cut between teats	4	
C—Fore udder full and well rounded, running well forward of front teats	10	
D—Rear udder well rounded and well out and up behind	6	
Teats 8:		
Of good and uniform length and size, regularly and squarely placed	8	

Scale of Points for Judging the Jersey Cow (continued)

	Counts	Student's Score
Milk Veins 4:		
Large, long, tortuous and elastic, entering large and numerous orifices	4	
Size 4:		
Mature cows, 800 to 1000 pounds	4	
General Appearance 10:		
A symmetrical balancing of all the parts, and a proportion of parts to each other, depending on size of animal, with the general appearance of a high-class animal, with capacity for feed and productiveness at pail	10	
Total	100	

*Scale of Points for Judging Jersey **Bulls***

	Counts	Student's Score
Head 10:		
A—Broad, medium length; face dished; narrow between horns; horns medium in size and incurving	5	
B—Muzzle broad, nostrils open, eyes full and bold; entire expression one of vigor, resolution and masculinity	5	
Neck 7:		
Medium length with full crest at maturity, clean at throat	7	
A—Shoulders full and strong, good distance through from point to point, with well defined withers; chest deep and full between and just back of forelegs	15	
B—Barrel long, of good depth and breadth, with strong, rounded, well sprung ribs	15	
C—Back straight and strong	5	
D—Rump of good length and proportion to size of body and level from hip bones to rump bones	7	
E—Loins broad and strong; hips rounded, and of medium width compared with female	7	
F—Thighs rather flat, well cut up behind, high arched flank	8	
G—Legs proportionate to size and of fine quality, well apart with good feet not to weave or cross in walking	5	
Rudimentary Teats 2:		
Well placed	2	
Hide 2:		
Loose and mellow	2	
Tail 2:		
Thin, long, reaching the hock, with good switch, not coarse or high at setting on	2	

Scale of Points for Judging Jersey Bulls (continued)

	Counts	Student's Score
Size 5:		
Mature bulls, 1200 to 1500 pounds	5	
General Appearance 15:		
Thoroughly masculine in character, with harmonious blending of the parts to each other; thoroughly robust, and such an animal as in a herd of wild cattle would likely become master of the herd by the law of natural selection and survival of the fittest	15	
Total	100	

QUESTIONS

1. Where did the Jerseys originate as a breed? Upon what foundation stock?
2. What law was most valuable in establishing this breed?
3. How large is Jersey Island?
4. Where is it located? Find it on the map.
5. For what products, other than cows, is the Island of Jersey noted?
6. How was improvement in the breed brought about?
7. What is the present plan of registration of cattle on the island?
8. Tell how the Jersey on the island is handled and fed.
9. What is the color of pure-bred Jerseys?
10. What are the average sizes of cow and bull?
11. How large is a Jersey calf at birth?
12. What may be said of the intelligence and the affection of the Jersey?
13. When may these good qualities prove a disadvantage?
14. What quality of milk do Jerseys produce?
15. How was the richness of Jersey stated before the Babcock test was invented?
16. Under what conditions may the larger fat globule be of value?
17. When were Jerseys first imported into America?
18. How widely distributed is this breed at the present time?
19. What is meant by American type Jersey?
20. How do they differ from the Island type Jersey?
21. What precaution should be taken in mating Jerseys?
22. What is constitution?
23. Why can Jerseys produce butter fat cheaper per pound than any other breed of cows in America?
24. What are her particular adaptations?
25. What improvement is most needed in the Jersey breed?
26. What is the "register of merit"?
27. What is the best year's record for a Jersey? What cow holds it?
28. Compare the Jersey and Holstein breeds.

CHAPTER XI

AYRSHIRES

Origin.—In comparison with the Holstein and Brown Swiss, which are virtually the pure descendants of the cattle of antiquity, or even with the Guernsey and Jersey which are modifications of the more or less mixed foundation stock, the Ayrshire breed of cattle may be said to be "man made." It is the youngest dairy breed of importance. In the Shire or County of Ayr, southwest Scotland, there lived in the early eighteenth century a number of farmers who seemed to have become convinced that their stock would admit of improvements, and set about to do it. The animals of 1750 are described as undersized, ill-fed, irregular, and as producing but little milk. They were, however, extremely hardy. They were undoubtedly the domesticated representatives of the aboriginal wild cow of that region and related to the West Highlands in that respect. In the mountains of Wales there are still to be found small black, extremely hardy, wild cattle and in England there are still a few specimens of an aboriginal wild white cow. During the latter half of the eighteenth century there was a strong movement towards the improvement of all neat cattle. These cattle were improved largely by crossing in other better developed breeds. Just when certain bloods were introduced is not accurately recorded, but it was evidently the early introduction of the blood of the old Teeswater breed, later known as Durhams, and still later more widely known as Shorthorns, that gave scale to the hardy little native cattle. At this time the Teeswaters were large, rather beefy and not particularly well refined. Their cross with the little, nervy, native stock must have produced a great mixture of characteristics, for soon, it is believed, there was an introduction of breeding cattle from Holland, animals essentially like our present Holstein. This was evidently done to improve the milking qualities, but with such a mixture, the breed became too large and lacking in the nimble grazing qualities necessary for the Scottish hillside pastures. At this juncture it is thought that there was introduced the blood of Jersey char-

acter to add refinement, to reduce the size, and yet to hold the milking qualities. The West Highland, Hereford and Devon bloods were probably introduced into a few herds, but whether any appreciable amount of the blood of the latter has been handed down in those animals that formed the Ayrshire is not known.

Home Conditions.—The land in the country of Ayr, Scotland, rises from the ocean on the west, rapidly into the mountains 2000 or more feet in height. Though cold in winter, the climate is not hot in summer. Plentiful rainfall keeps the grass on the clay pastures abundant. Thus the Ayrshire cattle were developed under the cool, rugged conditions where grazing ability was essential.

The birth-place of the Ayrshire breed of cattle in close proximity to the magnificently developed beef breeds of both Scotland and England doubtless had its influence in the development of symmetry and beauty in this dairy breed. And certain it is that the Ayrshire breeders have set a pace in the matter of beauty and poise of the animal which the adherents of other dairy breeds find hard to follow (Fig. 33).

Importation to America.—Early in the nineteenth century Ayrshires were brought to Canada and soon after herds were established in New England. Some are thought to have been brought to Connecticut as early as 1822. Many of the Ayrshire herds of the eastern states are the descendants of these early importations. Larger numbers of better developed animals were brought over later. Importations are still being made.

Body Characteristics.—The Ayrshire ranks as a middle-weight dairy breed, mature cows weighing in the neighborhood of 1000 pounds and bulls ranging from 1500 to 2000 pounds. For many years the plump form was held to, in the endeavor to retain the beef-making qualities along with the dairy. These are now spoken of as "tubby" and as being too plump to be ideal representatives of the breed. The present ideal for a cow is an animal of greater scale, deeper body, and more angularity (Fig. 34). The beautiful, straight back, level rump, long rear quarters and symmetrical udder are being retained and the short teats of the past are being developed past the point of criticism. In color the American Ayrshire is often a deep red,

streaked with seal brown, giving a brindle effect, but ranging from this to a clear cherry red and white (Fig. 35). The desire for white on the part of the Scottish and Canadian breeders became current a few years ago, with the result that the ideal animals of the present are three-fourths or more pure white and the remaining part a dark red, often assuming a seal brown shade, especially in bulls. The temperament of the Ayrshire is pronounced. The timid, yet forceful and active manner of the aboriginal wild stock used as foundation stock many hundred years ago still asserts itself. Most cows of this breed, though not vicious, are a little hard to handle, because so headstrong.

Fig. 33.—A champion Ayrshire Bull, Bargenoch Gay Cavalier. Note the beautiful and rugged outlines and deep chest. (Property of Adam Seitz, Waukesha, Wis.)

Their character must be taken into account in handling them. Their grazing qualities are phenomenally good. Their feet are sound, their legs are straight and they are buoyant. Whether for hillside climbing or nibbling of the short grass in semi-arid western prairies, the Ayrshires lead all other breeds of dairy cows.

The calves at birth are plump, well muscled and weigh about seventy-five pounds. They are quick to stand and easy to raise. The heifers do not mature very rapidly compared with the Jersey, but sufficiently early for all practical purposes. While

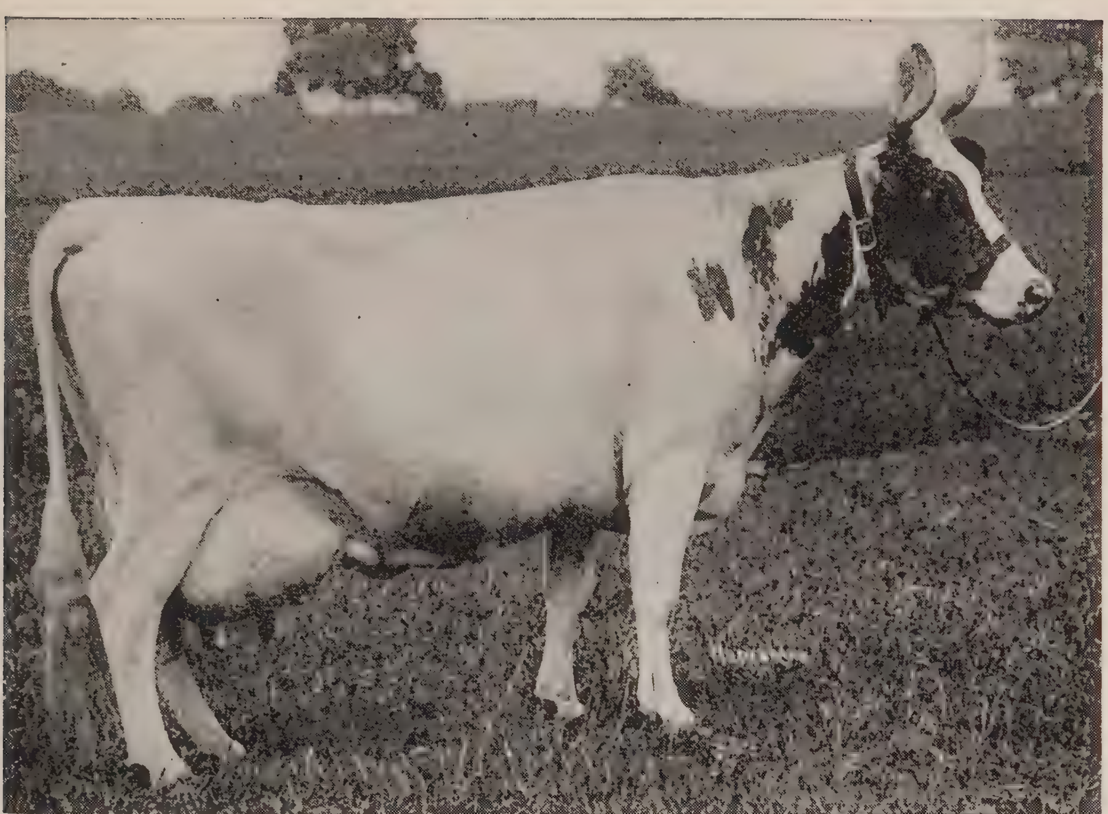

Fig. 34.—A typical modern Ayrshire cow. The deep body and rugged frame are now sought rather than the short "tubby" form. Note the well-balanced udder, good sized, well-placed teats, and the large crooked milk vein.

Fig. 35.—Imp. Ayrshire bull Duchrae Success. (Owned by the late J. J. Hill, St. Paul, Minn.)

not immune to any of the diseases that afflict cattle, they are more nearly free from them than other dairy breeds. They are remarkable for the regularity with which they will breed and the number of years that they will keep at work.

Dairy Qualities.—Most Ayrshires of the present time carry too much meat to be pronounced dairy animals, though the present tendency is towards the more extreme dairy type. The yield of milk is moderate for its grade, though some very creditable records have been made (Fig. 36). An average of twenty-four animals reported by American Experiment Stations shows a milk yield per year of 6533 pounds, having 3.85 per cent fat and yielding 257 pounds of fat.

The advanced registry for this breed was inaugurated in 1902 with the requirements as follows: Cows two years old or under must produce 6000 pounds of milk containing 214.3 pounds of butter fat. For each day over two years a 0.06 pound increase in fat is demanded and 1.37 pounds in milk, with the requirement increasing until at five years of age or older she must produce 8500 pounds of milk containing 322 pounds of fat. Bulls scoring 80 points and having two daughters from different dams in the Advanced Registry, or without scoring, 54 daughters in Advanced Registry, are themselves admitted into the Advanced Registry.

The best ten living Ayrshires with official yearly records are:

Name	Record No.	Milk Lbs.	Fat Lbs.
Auchenbrain Brown Kate 4	27943	23022	917.60
Garclaugh Spottie	27950	22589	816.25
Lily of Willowmoor	22269	22106	888.70
Auchenbrain Yellow Kate	36910	21123	888.33
Gerranton Dora 2nd	23853	21023	804.79
Rena Ross 2nd	25295	18849	713.56
Jean Armour	25487	20174	774.73
Netherland Brownie 9th	23985	18110	820.91
Agnes Wallace of Maple Grove	25171	17657	821.45
Keepsake 2nd	26013	17410	711.27

The above are certainly very creditable records and indicate strongly the probability that with more thorough development of the deep body and angularity sought at the present time, this breed will rival the other dairy breeds even more closely in the

future than in the past in the matter of total production. Especially is this indicated by the recent record of 17,974 pounds of milk containing 738.32 pounds of fat produced in one year by the senior two-year-old heifer, Henderson's Dairy Gem 35176, which is the record for all breeds for the age.

FIG. 36.—Imp. Ayrshire cow, Kilnforn Bell 3d. Grand champion for the breed at the National Dairy Show, Chicago, 1913.

Average of All Advanced Registry Records to November 1, 1915.

	Milk Lbs.	Fat Lbs.	Fat Per cent
657 mature cows	10830	420.05	3.89
101 Senior 4 yr. old	10281	396.00	3.86
144 Junior 4 yr. old	9574	376.31	3.93
176 Senior 3 yr. old	8949	365.28	3.99
175 Junior 3 yr. old	8773	344.22	3.94
277 Senior 2 yr. old	8503	337.32	4.02
316 Junior 2 yr. old	7478	311.26	3.99
1846 total cows and heifers	9405	371.88	3.94

Adaptations.—It is evident from what has been said that the place for the Ayrshire will, in the future as in the past, be found closely associated with the mountainous sections, but that in addition she is being sought by those farmers of our west, whose stock must graze on the short grass pastures of the region of scanty rainfall. The fact that the Ayrshire has been known and advertised as a very hardy cow, doing better under hard conditions than most or any other breed, has undoubtedly attracted to this breed men who propose to give loose care and to subject the animals to hardships. No breed could develop rapidly under such management. The Ayrshire is a beautiful and a useful cow worthy of being kept in greater numbers.

Scale of Points for Judging Ayrshire Cows

	Counts	Student's Score
Head 10:		
Forehead, broad, and clearly defined	1	
Horns, wide set on and inclining upward	1	
Face, of medium length, slightly dished, clean cut, showing veins	2	
Muzzle, broad and strong without coarseness, nostrils large	1	
Jaws, wide at the base and strong	1	
Eyes, full and bright with placid expression	3	
Ears, of medium size and fine, carried alert	1	
Neck, fine throughout, throat clean, neatly joined to head and shoulders, of good length, moderately thin, nearly free from loose skin, elegant in bearing	3	
Fore Quarters 10:		
Shoulders, light, good distance through from point to point, but sharp at withers, smoothly blending into body	2	
Chest, low, deep and full between and back of forelegs	6	
Brisket, light	1	
Legs and feet, legs straight and short, well apart, shanks fine and smooth, joints firm, feet medium size, round solid and deep	1	
Body 13:		
Back, strong and straight, chine lean, sharp, and open jointed	4	
Loin, broad, strong and level	2	
Ribs, long, broad, wide apart and well sprung	3	

Scale of Points for Judging Ayrshire Cows (continued)

	Counts	Student's Score
Abdomen, capacious, deep, firmly held up with strong muscular development	3	
Flank, thin and arching	1	
Hind Quarters 11:		
Rump, wide, level, and long from hocks to pin bones, a reasonable pelvic arch allowed	3	
Hocks, wide apart and not projecting above back nor unduly overlaid with fat	2	
Pin bones, high and wide apart	1	
Thighs, thin, long and wide apart	2	
Tail, long, fine, set on a level with back	1	
Legs and feet, legs strong, short, straight when viewed from behind and set well apart; shanks fine and smooth, joints firm, feet medium size, round, solid and deep	2	
Udder, long, wide, deep, but not pendulous, nor fleshy, firmly attached to the body, extending well up behind and far forward, quarters even, sole nearly level and not indented between teats, udder veins well developed and plainly visible	22	
Teats, evenly placed, distance apart from side to side equal to half the breadth of udder, from back to front equal to one-third the length, length 2½ to 3½ inches, thickness in keeping with length, hanging perpendicular and not tapering	8	
Mammary Veins, large, long, tortuous, branching and entering large orifices	5	
Escutcheon, distinctly defined, spreading over thighs and extending well upward	2	
Color, red of any shade, brown, or these with white; mahogany and white, or white; each color distinctly defined. (Brindle markings allowed but not desirable.)	2	
Covering 6:		
Skin, of medium thickness, mellow and elastic	3	
Hair, soft and fine	2	
Secretions, oily, of rich brown or yellow color	1	
Style, alert, vigorous, showing strong masculine character, temperament inclined to nervous, but still docile	4	
Weight, at maturity not less than one thousand pounds	4	
Total	**100**	

Scale of Points for Judging Ayrshire Bulls

	Counts	Student's Score
Head 16:		
Forehead, broad and clearly defined	2	
Horns, strong at base, set wide apart, inclining upward	1	
Face, of medium length, clean cut, showing facial veins	2	
Muzzle, broad and strong without coarseness	1	
Nostrils, large and open	2	
Jaws, wide at base and strong	1	
Eyes, moderately large, full and bright	3	
Ears, of medium size and fine, carried alert	1	
Expression, full of vigor, resolution and masculinity	3	
Neck 10:		
Of medium length, somewhat arched, large and strong in the muscles on top, inclined to flatness on sides, enlarging symmetrically towards the shoulder, throat clean and free from loose skin	10	
Fore Quarters 15:		
Shoulders, strong, smoothly blending into body with good distance through from point to point and fine on top	3	
Chest, low, deep and full between back and forelegs	8	
Brisket, deep, not too prominent, and with very little dewlap	2	
Legs and feet, legs well apart, straight, and short, shanks fine and smooth, joints firm, feet of medium size, sound, solid and deep	2	
Body 18:		
Back, short and straight, chine strongly developed and open jointed	5	
Loin, broad, strong and level	4	
Ribs, long, broad, strong, well sprung, and wide apart	4	
Abdomen, large and deep, trimly held up with muscular development	4	
Flank, thin and arching	1	
Hind Quarters 16:		
Rump, level, long from hocks to pin bones	5	
Hocks, medium distance apart, proportionately narrower than in female, not rising above the level of the back	2	
Pin bones, high, wide apart	2	
Thighs, thin, long and wide apart	4	
Tail, fine, long, and set on a level with back	1	
Legs and feet, legs straight, set well apart, shanks fine and smooth; feet medium size, round, solid and deep, not to cross in walking	2	

Scale of Points for Judging Ayrshire Bulls (continued)

	Counts	Student's Score
Scrotum, well developed and strongly carried	3	
Rudimentaries, veins, etc., teats of uniform size, squarely placed, wide apart and free from scrotum; veins long, large tortuous, with extensions entering large orifices; escutcheon pronounced and covering a large surface	4	
Color, red of any shade, brown, or these with white, mahogany and white, or white; each color distinctly defined	3	
Covering 6:		
Skin, medium thickness, mellow and elastic	3	
Secretions, oily, of rich brown or yellow color	1	
Hair, soft and fine	2	
Style, active, vigorous, showing strong masculine character, temperament inclined to nervousness, but not irritable or vicious	5	
Weight at maturity not less than 1500 pounds	4	
Total	100	

QUESTIONS

1. Where did the Ayrshire develop?
2. What blood elements were used in building the breed?
3. Describe the native home conditions of the Ayrshire.
4. How have the near-by beef breeds influenced this dairy breed?
5. When were they imported into America?
6. Describe an Ayrshire cow, as to color, size, temperament, grazing ability, outline and general breeding and handling qualities.
7. What conditions seem to call for the Ayrshire cow?
8. Is she an intense dairy animal?
9. What is the best record to date?
10. How does the average fat produced compare with the other breeds of cattle?

CHAPTER XII

THE RED POLLS

The Red Polled cattle are of ancient English origin. Whether the foundation stock came from the continent with the Scandinavian settlers of Suffolk in the fifth century A.D., or from some native aboriginal wild stock, will probably never be known. They were developed, however, at a very early period in the two counties of Norfolk and Suffolk in eastern England. In Norfolk they were beefy and poor milkers, dark red in color and hardy. In Suffolk they were of indifferent beef value, but considered as very good dairy cows and were without horns. The present breed is the result of an amalgamation of the two types which was accomplished more than a hundred years ago.

Home Conditicns.—The home of this breed was on low hills and marshes. While the soil was not always of the best, the climate was mild and moist, thus encouraging ample pasturage. It is natural, indeed, to expect from such conditions, coupled with good care, that the animals should grow large, mature early and be generally responsive. Such is found to be the case.

Importations to America.—While it is thought that animals of the Red Polled stock were brought to this continent with the early English colonists at Jamestown, Virginia, because of the prevalence in the eastern states of a red muley cow, it is known that better developed animals of this breed were imported in 1847 to Massachusetts. From 1873 to 1887 large numbers were brought over. The Red Polled Cattle Club of America was organized in November, 1883.

Body Characteristics.—The color of the Red Polls is a solid deep red with an occasional white patch on the udder, belly or switch. The size is medium to large, mature cows weighing from 1200 to 1600 pounds or more, and bulls from 1800 to 2400 pounds. As their name indicates, the breed is entirely without horns (Fig. 37). In general bodily make-up they are not so thick in the neck, back or leg as the beef breeds nor as

thin as the more pronounced dairy breeds. They are not so angular as many Shorthorns nor as compact as the Hereford. The temperament of Red Polls is somewhat nervous but not disagreeably so. Calves weigh from eighty to ninety pounds at birth, are strong, easy to raise and mature in medium time compared with other breeds.

Dairy Characteristics.—From the earliest records the Suffolk cattle were known as good dairy cows. It is recorded that some whole herds, while on good pasture, would average five or six gallons of milk per day, while a few of the best cows yielded as much as seven or eight gallons per day. The Norfolk cattle with which the Suffolk were blended were more on the beef order, consequently the modern Red Polls are probably not as free milkers as were the old Suffolks. The milk, however, is richer.

The herd of Mr. Garret Taylor, of England, consisting of ninety-eight cows, is reported as averaging 5582 pounds of milk in 1896, while in 1895 with eighty-seven cows in corresponding condition as to age, averaged 5540 pounds. Lord Rothschild's herd at Tring Park, England, has been selected with a special view to milk production. Thirty-seven cows, in 1896, averaged 6937 pounds of milk. In smaller herds more rigidly selected for dairy purposes there were even higher yields (Fig. 38).

In America, until recent years, the breed has been handled more largely by beef fanciers than by dairymen, yet some very creditable records have been made. At the Pan-American Model Dairy at Buffalo in 1901, this breed ranked fifth in a class of ten of the best dairy breeds of the country. Many three-day records of three to four pounds of fat per day have since been made at various state fairs.

The Advanced Registry was inaugurated in December, 1908. In this only yearly records are recognized. "Only such cows as have made officially authenticated butter fat records not less in amount than 6000 pounds of milk or 300 pounds of butter fat in twelve months shall be eligible to advanced registry." In addition: "A cow to be eligible to entry with description must scale at least eighty points of the official scale of points and must weigh not less than 1100 pounds."

This last clause with respect to size and score could well be emulated by every other breed of dairy cows.

Fig. 37.—Typical Red Polled bull, Teddy's Best, a champion at many fairs, head of the herd at Jean Du Luth Farm, Duluth, Minn.

Fig. 38.—Typical Red Polled cow, Jean Du Luth Beauty (A. R.), World's champion Red Polled cow. Record 20,280.6 pounds milk, 891 pounds butter fat in one year. (Bred and owned by the Jean Du Luth Farm, Duluth, Minn.)

Official Milk Records.—The best ten yearly milk and fat records for this breed up to February 1st, 1916, are as follows:

No.	Name	Milk	Fat
31725	Jean Du Luth Beauty	20280.6	891.58
28991	Jean Du Luth Pear	16598.4	707.24
24888	Pear	13160.6	603.66
26619	Flora	12590.0	595.73
31787	Jean Du Luth Dorothy	11614.8	571.46
26378	Diana 2nd	12622.1	536.80
28991	Jean Du Luth Pear	13538.4	546.34
26498	Liza	10807.75	515.25
11298	Gold Drop	11889.50	510.62
31726	Jean Du Luth Peach	11357.20	501.08

The best record by any one herd has been made by the Jean Du Luth Farm, Duluth, Minnesota, with mature cows as follows:

	No. Cows in Herd	Average Lbs. Milk	Average Lbs. Fat
1912	26	6529	268.00
1913	24	7645	316.27
1914	24	9818	403.50
1915	20[1]	10781	467.20
1915	13[2]	11274	479.93

Scale of Points for Judging Red Polled Cows

		Counts	Student Score
Color	Any shade of red. The switch of the tail and udder may be white, with some white running forward of the navel. Nose a clear flesh color. Interior of ears should be a yellowish waxy color	2	
	Objections: An extreme dark or an extreme light red is not desirable. A cloudy nose or one with dark spots.		

[1] Include records of six heifers with first calf and one incomplete year of a mature cow.

[2] Include only records of mature cows.

Scale of Points for Judging Red Polled Cows (continued)

		Counts	Student's Score
Head	Of medium length, wide between the eyes, sloping gradually from above eyes to poll. The poll well defined and prominent, with a sharp dip behind it in center of head. Ears of medium size and well carried. Eyes prominent; face well dished between the eyes. Muzzle wide with large nostrils	6	
	Objections: A rounding or flat appearance of the poll. Head too long and narrow.		
Neck	Of medium length, clean cut, and straight from head to top of shoulder with inclination to arch when fattened, and may show folds of loose skin underneath when in milking form	3	
Shoulder	Of medium thickness and smoothly laid, coming up level with line of back	6	
	Objections: Shoulder too prominent, giving the appearance of weakness in heart girth, shoulder protruding above line of back.		
Chest	Broad and deep, insuring constitution. Brisket prominent and coming well forward	10	
Back and Ribs	Back medium long, straight and level from withers to setting on of tail, moderately wide, with spring of ribs starting from the back bone, giving a rounding appearance, with ribs flat and fairly wide apart	14	
	Objections: Front ribs too straight, causing depression back of shoulders. Drop in back or loin below the top line.		
Hips	Wide, rounding over the hooks, and well covered	3	
Quarters	Of good length, full, rounding and level; thighs wide, roomy and not too meaty	6	
	Objections: Prominent hooks and sunken quarters.		

Scale of Points for Judging Red Polled Cows (continued)

		Counts	Student's Score
Tail	Tail head strong and setting well forward, long and tapering to a full switch	2	
Legs	Short, straight, squarely placed, medium bone	3	
	Objections: Hocks crooked, legs placed too close together.		
Fore-Udder	Full and flexible, reaching well forward, extending down level with hind udder	10	
Hind-Udder	Full and well up behind	10	
Teats	Well placed, wide apart and reasonably good size	4	
	Objections: Lack of development, especially in forward udder. Udder too deep, "bottle shaped" and teats too close together. Teats unevenly placed and either too large or too small.		
Milk Veins	Of medium size, full, flexible, extending well forward, well retained within the body; milk wells of medium size	6	
Hide	Loose, mellow, flexible, inclined to thickness, with a good full coat of soft hair	5	
	Objections: Thin, papery skin or wiry hair.		
Condition	Healthy; moderate to liberal flesh, evenly laid on; glossy coat; animal presented in good bloom	10	
	Total	100	

General Description...Cow medium, wedge form, low set, top and bottom lines straight except at flank; weight 1300 lbs. to 1500 lbs. when mature and finished.

Scale of Points for Judging Red Polled Bulls

		Counts	Student's Score
Color	Any shade of red. The switch of the tail may be white, with some white running forward to the navel. Nose of a clear flesh color. Interior of ears should be of a yellowish, waxy color	2	

Scale of Points for Judging Red Polled Bulls (continued)

		Counts	Student's Score
	Objections: An extreme dark or an extreme light red is not desirable. A cloudy nose or one with dark spots.		
Head................	Wide, strong and masculine, relatively short. Poll stronger and less prominent than in cow. Ears of medium size and well carried; eyes prominent; muzzle wide and large nostrils	12	
	Objections: Long, narrow or lacking in masculine character.		
Neck................	Of medium length, full crest, of good thickness, strong, of masculine appearance	5	
Shoulder	Of medium thickness and smoothly laid, coming up level with line of back...	8	
	Objections: Shoulder too prominent, giving the appearance of weakness of heart girth, shoulder protruding above line of back.		
Chest	Broad and deep, insuring constitution. Brisket prominent and coming well forward	12	
Back and Ribs........	Back medium long, straight and level from withers to setting on of tail, moderately wide, with spring of ribs starting from the back bone, giving a rounding appearance, with ribs flat and fairly wide apart.............	14	
	Objections: Front ribs too straight, causing depression back of shoulders. Drop in back or loin below the top line.		
Hips................	Wide, rounding over the hooks, and well covered	3	
Quarters	Of good length, full, rounding and level; thighs wide and moderately full, deep	6	
	Objections: Prominent hooks and sunken quarters.		
Tail.................	Tail head strong and setting well forward, long and tapering to a full switch	2	

Scale of Points for Judging Red Polled Bulls (*continued*)

		Counts	Student's Score
Legs	Short, straight, squarely placed, medium bone	3	
	Objections: Hocks crooked; legs placed too close together.		
Rudimentaries	Large, wide apart and placed well forward	12	
	Position of rudimentaries	6	
	Objections: Rudimentaries placed back on scrotum, or placed too close together, indicating tendency to transmit badly formed udders.		
Hide	Loose, mellow, flexible, inclined to thickness, with a good, full coat of soft hair	5	
	Objections: Thin, papery skin or wiry hair.		
Conditions	Healthy; moderate to liberal flesh, evenly laid on; glossy coat, animal presented in good bloom	10	
	Total	100	

General Description...Strong, impressive, low set and of good carriage. Weight 1800 lbs. to 2000 lbs. when mature and finished.

QUESTIONS

1. Where did the Red Polls develop? How?
2. What were their home conditions?
3. When were Red Polls imported into America?
4. Describe a Red Polled cow, as to color, form, size, performance, temperament.
5. Compare with other breeds.
6. Is the Red Poll a "dairy" breed?
7. When was the advanced registry inaugurated for this breed?
8. What qualities other than amount of milk and butter production must cows of this breed possess for admission into the advanced registry?
9. What is the best fat record for this breed?
10. What is the best record for any herd?

CHAPTER XIII

BROWN SWISS

The breed of cattle known in America as the Brown Swiss is probably the oldest pure breed in this country, if not in the world. Their origin is shrouded by the mists of the early dawn of the human race in Europe. Though some believe that the race is of Oriental origin it is practically certain that animals much of the type of the present Brown Swiss have inhabited the Alpine region since before human history began. Remnants of all sorts of animals and crude tools have been found in the mud in the bottoms of the lakes. There, amid the charred posts of the early lake dwellings of human inhabitants, cattle skulls of the short, broad type of the present Brown Swiss have been found. So far as we are concerned the Brown Swiss cattle have always lived where they are now found, in the valleys and on the mountain sides of Switzerland.

Though the Brown Swiss is the most important and by far the best known breed in America of all breeds having originated in Switzerland, there is another, the large spotted Simmenthaler or Fleckvieh breed of more importance in the home country. Aside from these two major, some minor breeds or variations have developed in the various valleys where the stock has been kept for ages with little admixture from without.

Home Conditions.—Switzerland, that mountainous little republic in southern Europe, comprises less than 16,000 square miles and of this only about 70 per cent is productive. The hill-side pastures are steep, making grazing laborious, but the grass growing in patches is usually well watered from the snows above. It is the custom there to turn the stock onto pastures as early as possible in the spring on the low levels and as the season advances and grass becomes green at higher altitudes, the cows are driven to pastures up on the mountain side; later to a yet higher plain. They are not brought back daily, but the milkmaid or man follows the herd. Every morning and every night the fresh milk

is made into cheese and stored in dairy houses at convenient points to be brought down later. With the first cold of the high-altitude pastures the cows retreat through a succession of grazing places to the valley, where they go into winter quarters. The cheese made from the cows while on the green grass and pure water of the mountain side is that which has made Switzerland famous, and from which a good share of the annual cheese income of 26,000,000 dollars is derived. During the long winter the cows are fed hay made from the lowland grass, carefully preserved roots, potatoes, and a very small quantity of grain. This is usually linseed oil cake. Hundreds of years of life largely in the open with the heavy climbing necessary to pasture and the heavy work done by cows as oxen have developed in this breed the qualities which now make it popular.

Body Characteristics.—The Brown Swiss is one of the heavy dairy breeds, the cows ordinarily reaching 1200 to 1400 pounds at maturity, while bulls frequently weigh a ton or more. (Fig. 39.) They are rather heavy of bone and generally coarse in make-up. Their top line is usually reasonably straight and the body deep, which gives them a symmetry broken only by their unusually broad heads and muzzles. The color of the animals of this breed varies from a silvery gray to almost black, the dark shade, however, is of a rich brown-black rather than the jet black of the Holsteins. A light colored strip is usually present down the back bone, and yellowish muzzles always present in the best marked animals. The disposition of the Brown Swiss is one of their assets, it being particularly mild and non-resentful. The various qualities differ somewhat, the animals raised more largely on the higher altitudes have become smaller, and those pastured more largely on the lower levels have attained greater size. Most cows are also used largely for working purposes as well as for the production of oxen and milk. These have developed heavy, coarse bones at the expense of both meat and milk qualities.

Calves usually weigh 100 pounds or more at birth, making quick gains for veal but maturing rather slowly as cows. This may be due in part to the fact that in Switzerland the heifers

are not bred to freshen until about three years of age. Though late maturing they are, like the Ayrshire, noted for their ability to continue at work until old age.

For a long period of time this breed has been considered in the home country a dairy breed but since good amount of flesh was desired on work animals those naturally were selected which perpetuated the meaty thighs and well covered back, rather than the more angular dairy type of animal. In America, however, the Brown Swiss has been considered in the dual purpose class and were so entered at the World's Fair in Chicago, in 1893, at Buffalo in 1901 and at St. Louis in 1904, but in 1908 the Brown Swiss Cattle Breeders' Association went on record asking fair associations to class this breed as strictly dairy cattle, and since then the breeding has been tending more strongly towards the production of a less meaty animal with better developed mammary organs and nervous temperament, in short, the refining of the breed toward the dairy type (Fig. 40).

Importation to America.—So far as recorded the first animals of this breed to be brought to America were imported in 1869, by Henry M. Clarke of Belmont, Mass. From Mr. Clarke's importation some two hundred or more animals are now descended. In 1882 other animals were imported by Mr. Scott of Massachusetts, and Mr. Harris of Connecticut. Since then various importations have been made until now it is estimated that ten thousand have been recorded, and that fully five thousand animals are now kept in New England, the middle west, and western states.

The popularity of the Brown Swiss is due quite as much to their rich color and quiet dispositions as to their meat or milk-making adaptations. They are so heavy, so strong, and so tractable and easy to handle that phenomenal loads are drawn by them as oxen. Animals of this breed are now, and have been for years, greatly sought in all the southern European countries, in Siberia, Russia, South America and Mexico as draft animals. In Mexico there is no draft animal more popular, for there the Brown Swiss cow is made to do triple service, to draw the load, to yield milk, and her own flesh as beef in the end (Fig. 8). Some

breeders in the United States are making a practice of catering to the Mexican trade in supplying these triple purpose animals. Of

Fig. 39.—A champion Imp. Brown Swiss bull, My Own Boy, belonging to J. P. Allyn, Delavan, Wis.

Fig. 40.—A champion Brown Swiss cow, Belle of Grattan. Note the placid disposition and strong frame. (Owned by J. P. Allyn, Delavan, Wis.)

late years the demand has been so keen for breeding stock that the government of Switzerland has felt it necessary to intervene to prevent the sale of their best animals to outside buyers.

Dairy Characteristics.—Since the Brown Swiss breeders have so recently taken decided stand to produce high type single purpose dairy animals it cannot be expected that the representatives will be uniform in their dairy capacity. A goodly number of individuals of the breed, however, have done reasonably well (Fig. 41). One of the leading herds of the breed belonging to E. M. Barton of Illinois is reported as having made yearly records as follows:

2 cows	12,000	to	13,000	pounds	milk
7 cows	11,000	to	12,000	pounds	milk
8 cows	10,000	to	11,000	pounds	milk
4 cows	9,000	to	10,000	pounds	milk
10 cows	8,000	to	9,000	pounds	milk
2 cows	7,000	to	8,000	pounds	milk

The highest amount of fat produced in one year was 513 pounds, while twenty-three showed a production of over 400 pounds. The Agricultural School of Plantahof, Fraubuender, Switzerland, reported the following from their herd of fifty cows:

1892	5782 pounds milk
1893	5500 pounds milk
1894	6117 pounds milk
1895	6307 pounds milk
1896	6252 pounds milk

The average percentage of fat was 3.77

F. H. Mason, U. S. Consul at Zurich, reported 6000 cows belonging to the Anglo-Swiss Condensed Milk Company at an average of 5115 pounds milk with 3.68 per cent fat, or a production of 188.23 pounds of fat per cow per year.

The advanced registry for this breed, called Registry of Production, was established in the year of 1911. The following are a few of the official records made since that time:

Official Seven-Day Records

Name	Lbs. Milk	Lbs. Fat
Naegle	394.2	14.619
Hirz	343.4	13.064
Mary Ann	512.6	12.791
Vogel	291.6	12.180
Sunlight	280.7	10.670

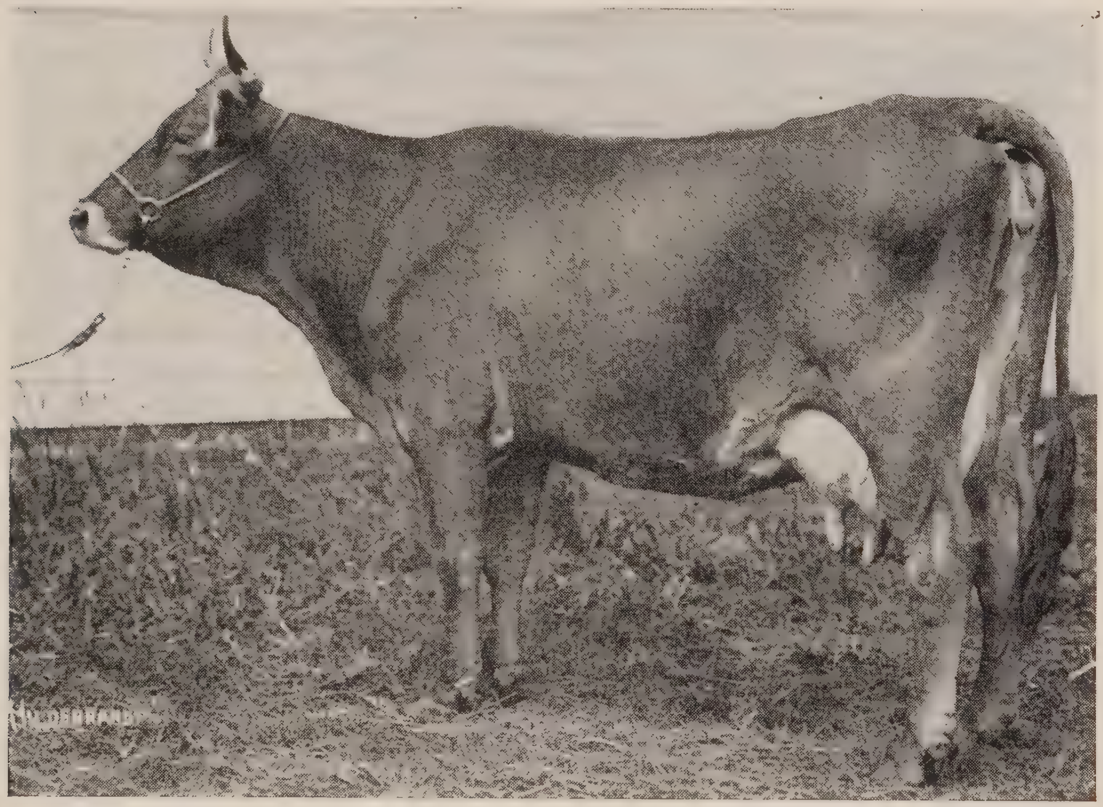

FIG. 41.—Brown Swiss cow, My One Baby, 3378, grand champion for the breed, National Dairy Show, 1912, and at the Michigan State Fair, 1913. Record, 15,769.6 pounds milk, 595.94 pounds fat.

Best Ten Yearly Records of Mature Brown Swiss Cows in Registry of Production, October 14, 1915

Name	No.	Lbs. Milk	Lbs. Fat
College Bravura 2nd	2577	19460.6	798.16
Kaliste W.	2905	16609.2	650.32
Merney	2859	14674.7	596.94
Zerelda	2929	14145.9	575.29
Madam Laughlin	2336	11960.3	522.43
Doris of Lakeview	3210	12949.3	519.23
Nellie Bly 2nd	2903	13520.2	511.63
Bee B.	2977	12212.7	508.97
College Bravura 2nd	2577	11786.2	500.39
Betty Brown	2146	11816.4	499.52

Adaptations.—From the foregoing it is evident that the places in which the Brown Swiss will serve better than other breeds are: First, where extreme dairy production is not of first importance. Second, as a general utility animal in the hands of people unaccustomed to the headstrong or active manner of other breeds. Third, the grades of this breed resemble very strongly pure bred Swiss. Pure bulls effect rapid improvement where dual or triple purpose animals are desired. They are a very healthy breed and produce very vigorous calves that are easily raised.

Scale of Points for Judging Brown Swiss Cows

	Counts	Student's Score
1. Head, medium size and rather long	2	
2. Face, dished, narrow between horns and wide between eyes	2	
3. Ears, large, fringed inside with light colored hair, skin inside of ear a deep orange color	2	
4. Nose, black, large and square with mouth surrounded by mealy colored band, tongue black	2	
5. Eyes, moderately large, full and bright	2	
6. Horns, short, regularly set with black tips	2	
7. Neck, straight, throat clean, neatly joined to head, shoulders of good length, moderately thin at the withers	4	
8. Chest, low, deep and full between and back of fore legs	6	
9. Back, level to setting of tail and broad across the loin	6	
10. Ribs, long and broad, wide apart and well sprung with thin, arching flanks	3	
11. Abdomen, large and deep	5	
12. Hips wide apart, rump long and broad	4	
13. Thighs, wide, quarters not thin	4	
14. Legs, short and straight with good hoofs	2	
15. Tail, slender, well set on, with good switch	2	
16. Hide of medium thickness, mellow and elastic	3	
17. Color—shades from dark to light brown, at some seasons of the year grey; white splashes near udder not objectionable, light stripe along back. White splashes on body or sides objectionable. Hair between horns usually lighter shade than body	4	
18. Fore udder, wide, deep, well rounded but not pendulous, nor fleshy, extending far forward on the abdomen	12	

Scale of Points for Judging Brown Swiss Cows (continued)

	Counts	Student's Score
19. Rear udder, wide, deep, but not pendulous, nor fleshy, extending well up behind	12	
20. Teats, rather large, set well apart and hanging straight	8	
21. Milk veins large, long, tortuous, elastic and entering good wells	6	
22. Disposition, quiet	2	
23. Size, evidence of constitution, and stamina	5	
Total	100	

Scale of Points for Judging Brown Swiss Bull

	Counts	Student's Score
1. Head, same as cow	2	
2. Face, same as cow	2	
3. Expression, full of vigor, resolution and masculinity	3	
4. Ears, same as cow	2	
5. Nose, same as cow	2	
6. Eyes, same as cow	2	
7. Horns, same as cow	2	
8. Neck, of medium length, somewhat arched, large and strong in muscles on top, sloping symmetrically to shoulders. Shoulders large and strong, smoothly blending into body	10	
9. Chest, same as cow	10	
10. Back, same as cow	10	
11. Ribs and abdomen, same as cow	10	
12. Hips, same as cow	6	
13. Thighs, same as cow	6	
14. Legs, same as cow	2	
15. Tail, same as cow	2	
16. Hide, same as cow	3	
17. Color, same as cow. Dark, smoky skins very objectionable	4	
18. Scrotum well developed and strongly carried	3	
19. Rudimentary teats, squarely placed wide apart and free from the scrotum	6	
20. Milk veins, same as cow	6	
21. Disposition quiet	3	
22. Size, evidence of constitution and stamina	4	
Total	100	

QUESTIONS

1. Where did the Brown Swiss breed originate?
2. What other breed in Switzerland is of more importance at home?
3. Describe the pasture conditions and habits of the home of the Brown Swiss.
4. Describe the Brown Swiss breed as to color, size, form and temperament.
5. What may be said of a Brown Swiss calf at birth?
6. Is the Brown Swiss a "dairy" breed?
7. When were animals of this breed imported into America?
8. Where are Brown Swiss cattle particularly popular?
9. Compare the yearly butter yields with other breeds.
10. What places in American agriculture will this breed fill better than any other?

CHAPTER XIV

SHORTHORN

THERE is probably no other breed of cattle in America that is favored by so large a number of farmers as the Shorthorn. Her blood is the foundation of much of the common or grade stock kept throughout the entire United States, predominating in the middle and north central states, yet well represented in the herds of New England, the south and the far west. A large portion of the milk which has made Minnesota, Iowa and Wisconsin well known as dairy states has been drawn from grade Shorthorn cows.

Origin.—The Shorthorn is a breed of old English origin. In the northeastern part of the country in the valley of the River Tees there was developed by selection and good feeding a strain of cattle considerably superior to those in the neighboring districts. Their improvement took place chiefly in the three counties of Durham, York and Northumberland. Early in the eighteenth century bulls are believed to have been imported from Holland by a Mr. Dobinson. Years later his and his neighbors' herds were well known for their superiority over the stock of the surrounding country which had been more largely descended from the native wild animals of the Island or from stock brought in during the Roman and Norman conquests.

The real improvers, almost the originators of the breed, may be said to have been the brothers Charles and Robert Colling, Robert Bakewell, Thomas Bates, Thomas Booth and Amos Cruickshank. Mr. Bates bred for milk as well as for beef, while Messrs. Booth and Cruickshank emphasized the meat-making quality. To these men and others who followed close after them, belongs most of the credit for starting the great improvement in livestock which has meant so much in every way, not only to all England but to all North and South America, South Africa, Australia, New Zealand, and in fact to much of the civilized world to-day. Not only was it the cattle produced but also the example, the pointing out of the possibility to other men for

other breeds and classes of livestock that made their work so lasting.

Importation to America first occurred in 1783 by Gough and Miller of Virginia, though not under the name of Shorthorn. In 1791 and 1796 Mr. Heaton brought Shorthorns to New York state, then for the next fifty years importations were numerous. During all this time the breed was multiplying rapidly and being extended westward as rapidly as the country was developed. Thus it may be said that the Shorthorn breed was "in on the ground floor" in America, was the cow of the cottagers and the frontiersmen. This unquestionably accounts for a part of its general favor to-day.

The adaptability of this breed is excellent. It does well from the tide meadows of the Atlantic to the mountain sides in the west, and from the Gulf of Mexico to Hudson Bay.

Body Characteristics.—In color the modern Shorthorn is white, or red and white, or roan. The size is large, cows weighing at maturity 1300 to 1600 pounds or more, and bulls from 2000 to 2600 pounds. In build they are generally blocky and broad (Fig. 42). Naturally so, since "all of the really great British breeders had in mind the importance of the Shorthorn as a beef producer and Cruickshank gave this feature special distinction," and since, too, the cattle business of America has until recent years been largely one of beef raising on cheap lands with just enough milk to furnish the home table. A very large percentage of the pure bred Shorthorns in America, very naturally, now carry strains of the Scotch or Cruickshank blood. The calves weigh from seventy-five to ninety pounds at birth and are comparatively easy to raise.

The dairy characteristics of the present American Shorthorn cattle are very variable. Those that have been selected for milk as well as for beef purposes and have been hand milked show considerable of the essential dairy type and are fair milkers, while those herds and strains in which the Scotch or Cruickshank element predominates are excellent for beef but lack in dairy power. The beef Shorthorn, however, gives more milk than some of the other beef breeds and for this reason start their calves off in excellent shape. Some beef producers prefer the Shorthorn for

their calf feeding ability even though they may fall a little short in intensity of beef form. It is not claimed, however, even by the breed's fanciers that the "milking" Shorthorn can rival the best

Fig. 42.—A good type milking Shorthorn bull, property of University of Minnesota Agricultural College. (Courtesy T. G. Paterson.)

Fig. 13.—Imported milking Shorthorn cow Bertha, belonging to the late J. J. Hill, St. Paul, Minn. Photo by author.

milk breed for milk production nor that highest beef and milk production will be found in the same animal, but rather that she occupies a mid-way position in the scale, being fairly good at both meat and milk production (Figs. 43 and 44).

The profitableness of such a combination will naturally vary with the kind of farming and dairying called for by conditions and the likes and dislikes of the owner. A full consideration of this question would fill a large chapter in a book on farm management.

Advanced Registry.—With "the aim and object of promoting the interests of the milking type of Shorthorn cattle" an advanced registry called "record of merit list" was established by the American Milking Shorthorn Cattle Club which was formed in December, 1912. The official beginning of the Record of Merit list was May 1st, 1915.

The rules require that, to be admitted to the record of merit list, cows must yield from 5250 pounds of milk containing 210 pounds of fat when starting the test at 30 months of age, up to 8000 pounds of milk containing 300 pounds of fat as mature cows, five years of age or over.

Two classes of records are admitted, A. A., those made officially by representatives of an Agricultural College or Experiment Station, and A, those made by cow testing association representatives.

The first milking Shorthorn year book appeared under date of 1915, and contained a goodly number of records.

The best ten from thirty-three, class A list, are as follows:

Record of Merit List

Name	Lbs. Milk	Lbs. Fat
Rose of Glenside	18075.2	624.76
Lulu	12341.4	514.79
Panama Lady	13779.5	489.46
Lady Clay 3rd	11928.0	484.13
Pearl of Silver Creek	10291.3	469.70
Lady Clay 2nd	10015.6	396.74
College Moore	9443.0	388.44
Reward of Nora's Dk.	9326.8	385.13
Harriet 2nd	8691.1	368.82
Brookside Lassie 2nd	8594.8	354.72

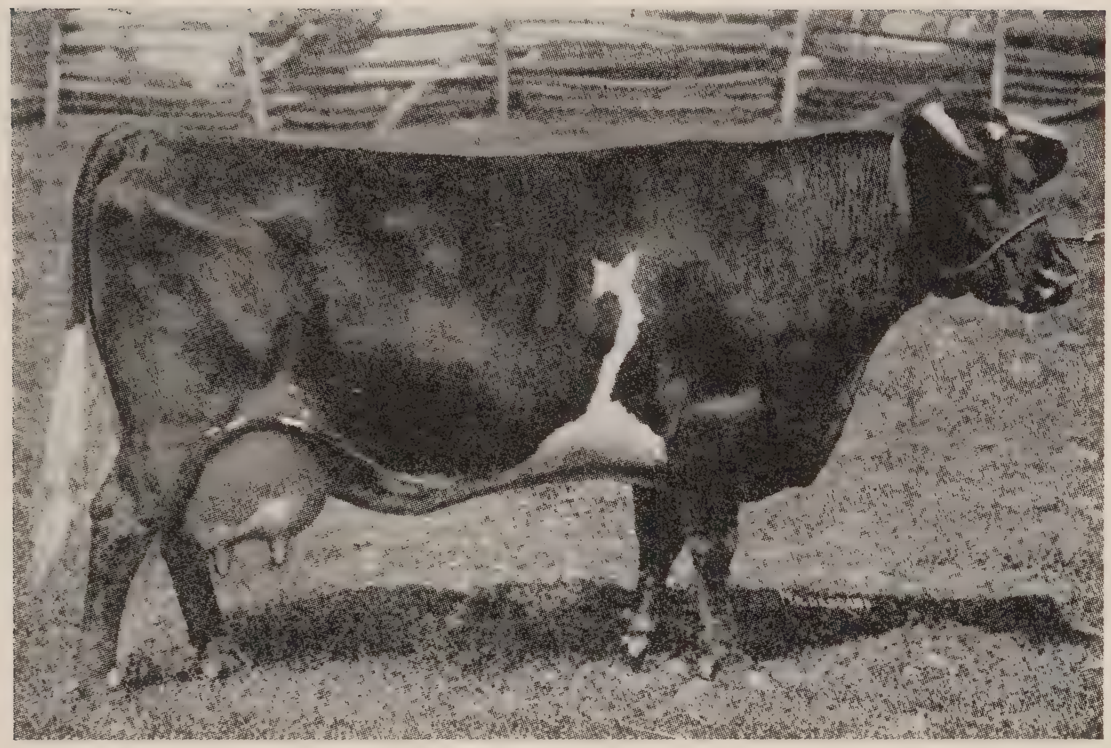

FIG. 44.—Jewel-milking Shorthorn cow, owned by May and Otis, Grandville Center, Pa.

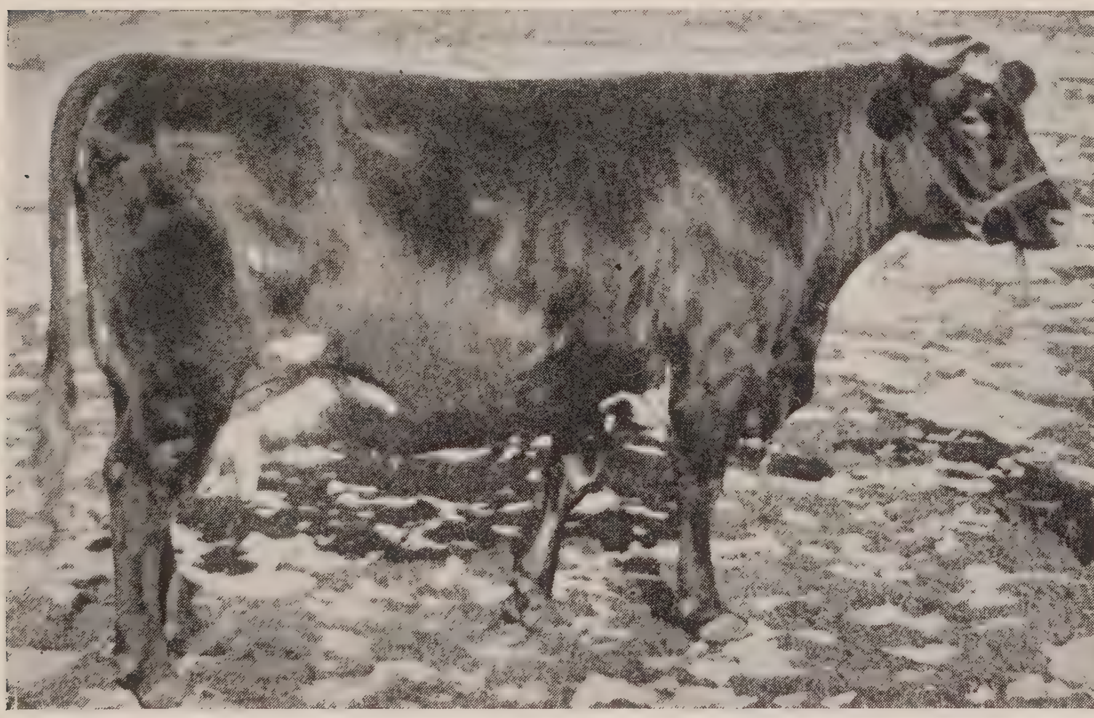

FIG. 45.—Good type milking Shorthorn cow belonging to W. C. Davis, Chester, Ia.

The average of the thirty-three yearly records reported by testing associations is 8520 pounds of milk containing 332 pounds of fat, while the 215 private records reported in the same volume range from 5500 pounds of milk up to 16,200 pounds of milk, fat not recorded. The lactation period recorded for these 215 unofficial records is from 168 to 365 days with an average of 344 days. Twenty-nine yearly or lactation periods (omitting two unusually short ones) averaged 5600 pounds of milk and 221 pounds of the fat at the Iowa Station. The fat average was 3.96 per cent (Fig. 45).

QUESTIONS

1. Where did the Shorthorn breed originate?
2. What breeders' names stand out clearly in the history of this breed? What did they do?
3. When were animals of this breed first brought to America?
4. What are its adaptations?
5. Describe a Shorthorn as to color, size, form, temperament and grazing qualities.
6. Tell why Shorthorn cows of this country are so very variable as dairy cows.
7. What is the "record of merit list"?
8. How do the ten yearly records compare with other breeds?

CHAPTER XV

DUTCH BELTED

The peculiarly marked breed of dairy cattle known in this country as the Dutch Belted, because of their color markings, are the production of the skill of the breeders in North Holland. Something more than 200 years ago the nobility of Holland for some reason fancied cattle of black and white color, but seemingly chose that the white should be in one piece extending around the middle of the animal. In Holland this breed goes by the name of "Lahenvelden," which means white field, but is also said to convey the idea of the "white body with black ends." These animals are, in all probability, closely related to the Holsteins or the descendants of the animals from which the present Holsteins have sprung. The Hampshire hogs of America and England, supposed to have originated in Hampshire, England, and also the Lahenvelden poultry of England and America, both of which have the white band about the middle with black extremities, are also, in all probability, the production of Holland skill. From a study of the size and general characteristics of the Dutch Belted cattle, it would seem evident that considerable difficulty had been experienced in the establishment of so odd a marking. No record is available, however, indicating the amount of inbreeding or breeding to physically inferior animals which may have been necessary during the earlier days of the establishment of the breed. The by-laws of breed associations of the present time conclude with: "White spots on an animal other than the feet, the belt, and the tip of switch considered a disqualification for registry. Color other than black and white or deformed or constitutionally defective, considered a disqualification. Beef form or absence of milk form emphatically objectionable."

Importation to America.—Although the breed attracted attention in Europe as early as 1750 there is no record of any having been introduced to America until 1838, when D. A. Haight brought over a few animals. In 1848 a second lot was

obtained. These were kept largely in New York State, and from these have descended a good portion of the animals now in America of that breed. In 1840 P. T. Barnum secured a number of Dutch Belted cattle for show purposes but soon retired them to his farm in Orange County, New York. Within a comparatively few years several importers have introduced the animals to Canada, Mexico, and Cuba, as well as having brought a few more into the United States. At present, though more

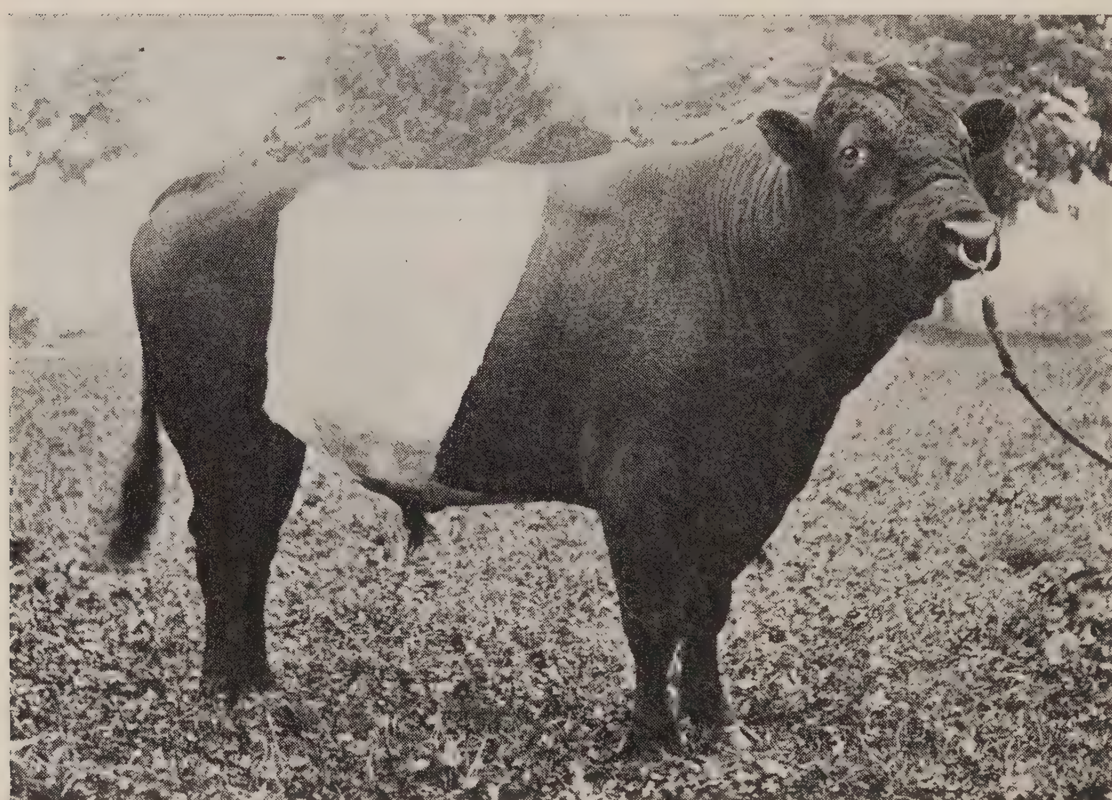

Fig. 46.—Champion Dutch Belted bull, Knox Em All, No. 646. (Owned by E. J. Kirby, Covert, Mich.)

numerous in the east, representative herds may be found in various places in the south and a few on the Pacific Coast. There are now about 500 breeders of Dutch Belted cattle in the United States.

Body Characteristics.—Although related to the Holstein the Dutch Belted breed falls far short of attaining to the same size. Mature cows weigh about 800 to 1000 pounds, and the bulls from 1500 to 1800 pounds. Their color is invariably jet black with a white band about their middle. No white is tolerated in the field

FIG. 47.—Champion Dutch Belted cow, Julia Marlowe, No. 1187. (Owned by Mrs. Jennie Strader, Ceres, Cal.)

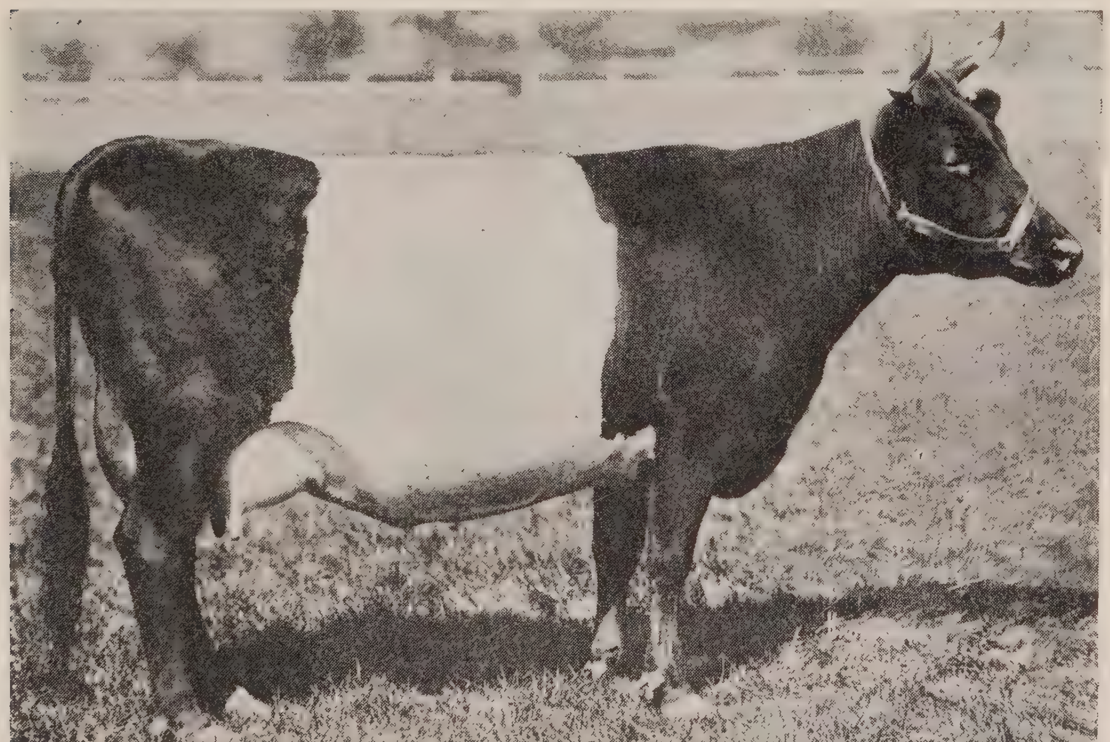

FIG. 48.—Tilma, 1302, a champion Dutch Belted cow.

of black, nor black in the field of white. In Holland white feet are permitted but they are objected to in the United States. They are very striking in appearance (Fig. 46). Their temperament is mild though not so placid as the Holstein.

Dairy Characteristics.—Although the Dutch Belted cattle are an old breed in Holland comparatively little attention has been given to them in America and until recently those that were maintained in this country were kept largely for their looks (Figs. 47 and 48). The advanced registry for the breed was established in May, 1914. Since that time official records have been made. A few of the best are here given.

In one herd, that of the Superintendent of the Advanced Registry, Dr. H. W. Lance, Peapack, N. J., seven cows have recently finished a year's work as follows:

Name	Age	Lbs. Milk	Lbs. Fat
Peapack Anna	4 yrs.	13159	484.31
Peapack Duchess	mature	13065	447.64
Peapack Pam	3 yrs.	10681	353.17
Peapack Dawn	mature	9345	348.87
Peapack Prejudice	4 yrs.	9243	328.22
Peapack Princess	2 yrs.	8745	312.17
Peapack Polly	2 yrs.	7332	254.33

QUESTIONS

1. What is the chief characteristic of the Dutch Belted breed?
2. Where was it developed? How?
3. When were animals of this breed brought to America?
4. Where are Dutch Belted cattle chiefly kept?
5. How many breeders are there in the United States?
6. Describe a Dutch Belted cow as to color, size and temperament.
7. Compare the advanced registry records of this breed with those of other breeds.

CHAPTER XVI

FRENCH-CANADIAN

The breed of dairy cattle which can, more nearly than any other, claim America as its home is the one generally known as the French-Canadian. Just when the first stock of this blood reached America is not absolutely known, though thought to be about 1620, or very soon thereafter. At any rate, in 1665, when other animals were brought from Normandy and Brittany to Quebec, cows were there discovered having the same characteristics as those imported. The stock unquestionably came from Northern France with the early settlers in the province of Quebec, Canada. Although there was for many years no particular endeavor made to keep the blood pure it did remain essentially pure, however, because of the very limited intercourse which those pioneers had with the none too friendly English-speaking people in the colonies.

For a period of about 200 years the descendants of these early importations have served the pioneers, cottagers, and small farmers of eastern Quebec. While sharing the pioneer life of the people who brought them they developed wonderful hardihood and health, and yet retained in reasonably good measure their dairy qualities.

Since 1886 the interests of the breed have been fostered and the breed itself materially improved by the French-Canadian Cattle Breeders' Association.

Body Characteristics.—The size of the French-Canadian is about that of the Jersey, which breed they so very closely resemble. Cows weigh from 700 to 900 pounds, though individuals reach greater weight, and the bulls at maturity weigh from 1600 to 2000 pounds (Fig. 49). Though still rather coarse and with an unfinished appearance, they are reasonably straight at top line, with strong broad hips and deep full chests. Their color, though ordinarily termed black, is not a true black in the sense of the Holstein, but rather a deep seal-brown-black. They often

though not always, have an orange or brownish line down the back. The young stock is frequently of lighter color, showing nearly a dark orange red. The calves of this breed are exceedingly hardy and easy to raise, but slow in reaching maturity, but like the Brown Swiss and other slowly developing breeds live and breed to an unusually old age.

Dairy Characteristics.—As a breed, the French-Canadian cow yields only a moderate amount of milk. Records, however,

Fig. 49.—The champion French-Canadian bull, Denis Lord, four years old. (Owned by Experimental Farm, Quebec, Can.)

of individuals in the herd best managed often show a milk production of 5000 to 6000 pounds in a year and 10,767 has been reported authoritatively. The quality of the milk ranks nearly equal to that of the Guernsey, a test of 5 per cent being not at all uncommon for the animals yielding a medium amount.

The Advanced Registry, called Record of Performance, was established in 1907. The best ten yearly records officially reported up to April 1st, 1916, are as follows:

Name of Cow	Reg. No.	Lbs. of Milk	Per cent Fat	Lbs. of Fat
Filie	29	10767	4.20	453
Denise-Champoine, 13	31	10140	4.07	413
Finette 2nd	41	9747	4.13	403
Zamora	10	7668	5.25	403
Florida	19	8412	4.81	403
Aromaz	33	7684	5.02	386
Inoquette	7	7876	4.80	378
Morlaisienne	24	7794	4.70	366
La Belle	8	7196	4.96	358
Maid of Two Mountains	39	6947	4.95	344

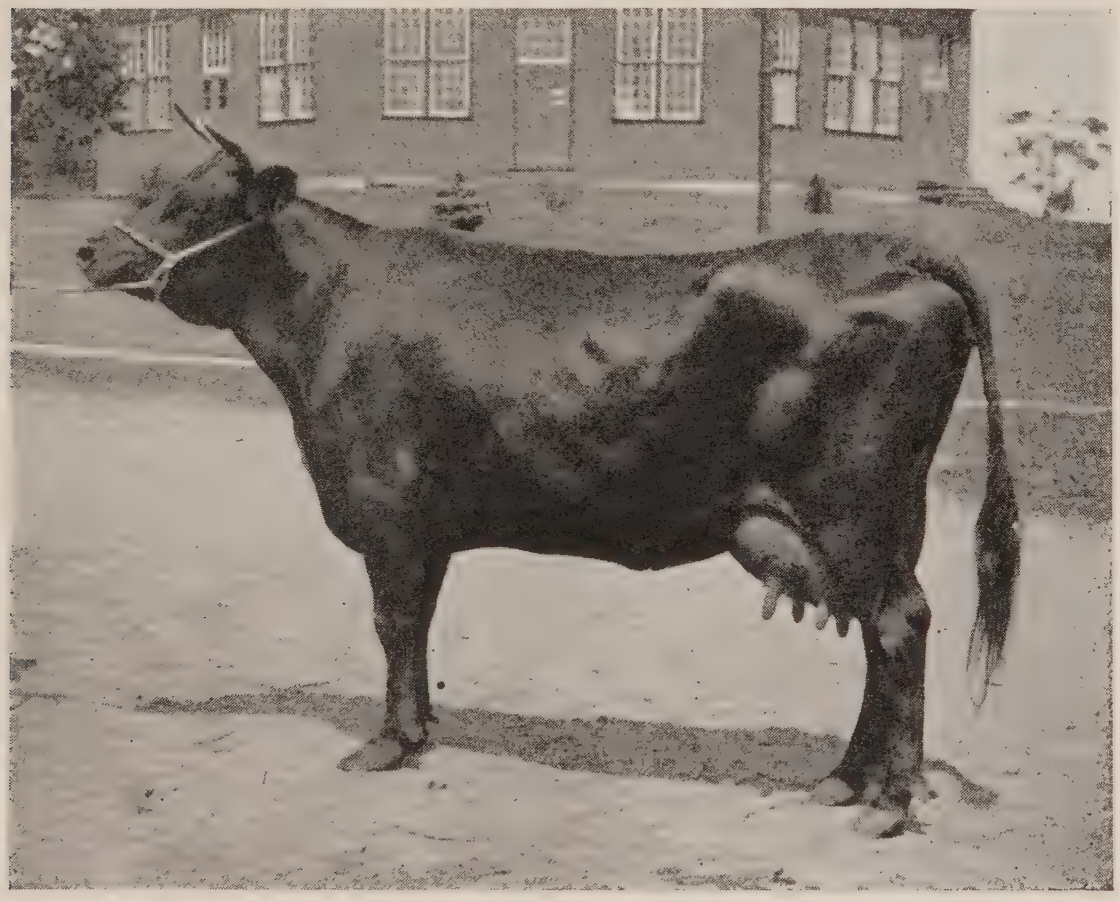

FIG. 50.—A champion French-Canadian cow. Fortune 4th, d'Ottawa 946. Record, one year, milk, 9135 pounds, test, 4.67 per cent fat, 428 pounds. (Courtesy Dominion Experimental Farm, Ottawa, Ontario, Canada.)

Requirements for Admission into Record of Performance

	Lbs. Milk	Lbs. Fat
Mature cows	6800	306
Four year old class	6000	270
Three year old class	5200	234
Two year old class	4400	198

This breed has the hardy qualities of the Ayrshire, with the added advantage of yielding a richer milk and of being both easier to handle as animals and more conveniently milked. Their teats are universally large and well placed.

The French-Canadian cattle are aptly said to be the "Jerseys of the north." Their place in the eastern provinces is very similar, indeed, to the one occupied by the Jersey farther south. They should be looked upon, however, as a "breed in the rough." With the excellent foundation possessed, however, there is no reason why, if skillfully bred and handled, the breed should not become refined and still retain a highly economic place. While there is little reason why this breed should be introduced seriously into the United States to satisfy any special need, there is good reason why it should be retained and developed in Quebec, Canada, and there continue to serve mankind (Fig. 50).

QUESTIONS

1. What breed of dairy cattle can claim America as its home?
2. Under what circumstances were the ancestors of the French-Canadian breed brought to this country?
3. From what country did they come?
4. Describe a French-Canadian cow as to color, size, form and disposition.
5. Discuss the dairy qualities of this breed.
6. Compare records with other breeds.
7. What may reasonably be expected of the French-Canadian breed?

CHAPTER XVII

MILCH GOATS

THE goat has been one of the faithful servants of man since the dawn of history, and still continues as the efficient converter of weeds, brush and various grasses into nutritious milk for infant or adult, or into strong wool or mohair for garment or rug making, or into savory flesh for food. Whether goats were domesticated and developed at a period earlier than cattle is not accurately known, but it is highly probable that such was the case because of the fact that they are smaller and milder in disposition.

Milch goats are nearly, if not quite, as common in most of the countries of Europe as are dairy cows. They have been developed to high points of usefulness in many separate sections of the country, though those best known in America (Fig. 51) are the descendants of one or more of the breeds which originated, or were improved in Switzerland. But in northern Africa, Russia, Norway, Germany, France and Spain, milch goats are to be found. They have likewise been introduced into other sections of the world and now occupy a small but useful place in most of the Spanish-American countries.

The Goat Maligned.—There is probably no single animal in America which has been the butt of more common jokes than the goat. This is probably due to the fact that most of the goats known in our villages and cities are of the common, scrub sort which are thought to be the inferior descendants of those brought to Mexico by the Spanish in the early days. They are about as much like the modern pure bred milch goats as old Texas range cattle are like Jerseys. The class of animals kept for the purpose of cheese making, largely in foreign countries, is scarcely known in America. The fact that the goat is spoken of as the "poor man's cow" certainly does not encourage their being more generally kept. The term is far from apt in America, however, for the reason that a good milch goat costs as much as a good cow. In view of the general attitude toward this animal they

should be called, rather the "brave man's cow." The humble position held by this animal in America is not warranted by scientific findings nor yet by practical experience.

Dairy Type in Goats.—It is certainly more than a coincidence that the type of the animal, developed through long ages of experience, which is found to be the most profitable as a milk producer possesses a type essentially very similar to that known

Fig. 51.—Imp. Fanette, No. 151, the champion milk producer of the Toggenburg breed in America. She produced in one year 2680 pounds of milk, or nearly twenty times her own weight. Note that she possesses the essentials of the dairy type. (Reproduced by courtesy of "Littlelands in America," San Francisco, Cal.)

as the dairy type in cows. The Saanan doe represented in figure 54, and the Toggenburg doe, another Swiss breed, shown in figure 52, agree essentially with the Spanish Maltese and with the African Nubian and show the extreme dairy type.

A study of these types reveals the presence of a large capacity for food consumption coupled with the angularity and loose construction of frame work which are essentially different from the

form best adapted for meat production. It will be remembered that the compact animals, whether cattle, horses, hogs, or sheep, are known to be the "easy keepers," which means "easy fatteners." Coupled with the capacious body and thin angular muscular development, the immense udder development will be observed.

Breeds.—Goats, varying in type all the way from the compact form of the mutton and wool producing varieties to the thin, angular, strictly dairy goats, are to be found in many sec-

FIG. 52.

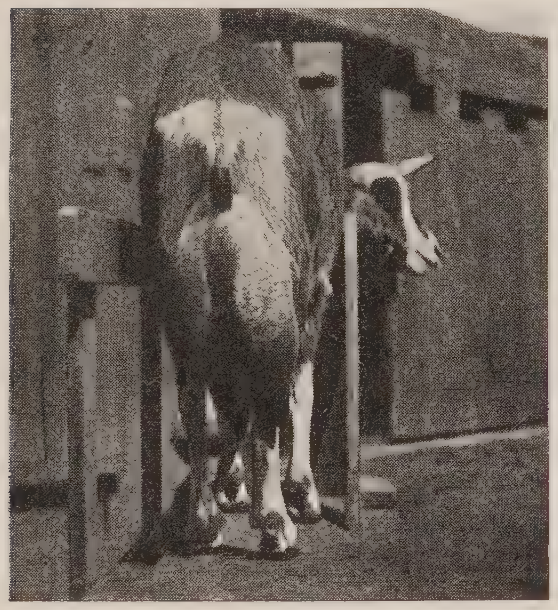

FIG. 53.

FIG. 52.—Fanette, the Toggenburg prize doe. Note wonderful development of udder. (Courtesy the owner, Winthrop Howland, Redlands, Cal.)
FIG. 53.—A well-marked Toggenburg doe.

tions of the country and are known by a great variety of names. The various breeds have not yet been classified and studied as have the different races and breeds of cattle. The following are brief descriptions of the dairy goats best known in America:

Toggenburg.—This breed originated in the Toggenburg Valley of Switzerland, in the northeast section of the republic. They are of medium size, weighing in the neighborhood of 125 pounds at maturity, rather slender, hornless, and short-haired. Their color is a peculiar shade of brown or mouse color with white markings, distributed with great regularity. The legs below the knees and hocks should be white, and a white strip runs

down either side of the face and around the ears (Fig. 53). They are hardy, gentle, and tractable and are said to yield four quarts of milk per day when fresh.

Saanen.—This pure white breed was originated and is now kept in the Saanen Valley in Switzerland. It is a breed of comparatively large animals, a mature doe occasionally weighing 150 pounds. They are hornless and being short-haired their angular form is prominent (Fig. 54). The quantity of milk accredited to this breed is from three to four quarts per day with isolated cases of five to six quarts, though two or three quarts would probably be more nearly an average for the nine to twelve months of lactation period or about 1800 pounds of milk for the year.

Spanish Maltese.—This animal from the Island of Malta is of two varieties, the short-haired and the long-haired. This is the breed which has been so extensively introduced into Mexico and other Spanish-American countries, and the one from which our common goat was probably descended. Some varieties of this breed grow horns, while others do not. They are about the size of the ordinary Angora, and are better adapted to warm than to cold climates. Their milking proclivities vary considerably with the breeding.

Milk Records.—A goat which gives less than a quart a day is not to be considered a good milch animal. If it yields two quarts it is a good animal, provided the period of lactation is nine months or more. In the European countries the goats which yield from three to five quarts a day are numerous and the period of lactation is a long one (Figs. 51 and 54).

It is a good goat of any breed that will average two and one-half quarts (5.25 pounds) of milk a day for eight or nine months of the year. One that will give more than this is specially desirable. The Angora goat, which is not considered a good milch animal, gives from two to three quarts of very rich milk but for a comparatively short time. The Nubian, or African, produces from five to ten quarts per day. The yield of the best goats of Switzerland averages about four quarts daily. This amount is not produced without good care and feed, however.

The yield of milk varies greatly as with cows, between breeds and individuals. Dettweiler reports the yields of twenty-four for a year as follows:

9	gave	1200—1400	pounds
7	gave	1400—1600	pounds
4	gave	1600—1800	pounds
1	gave	1800—2000	pounds
3	gave	2000—over	pounds

Fig. 54.—Milch goat of the Saanan breed which produced 1845 pounds of milk in one year at the New York (Geneva) Experiment Station.

Individuals are reported which have produced as much as 2400 pounds of milk, testing about 4 per cent fat or 96 pounds butter fat in one year. This would make about 115 pounds of butter or 240 pounds of cheese.

The Toggenburg doe, Geneva, reported by the California Experiment Station, was Grand Champion at the recent Panama-Pacific Exposition. She weighs on an average 127 pounds and in 312 days yielded 2158 pounds of milk containing 72.8 pounds of fat and 256.34 pounds total milk solids. Two others tested for a year yielded less. One half-breed, Delia, weighing only 104 pounds, produced only 1283 pounds of milk and 49.73 pounds of fat in a single lactation period of 310 days; and Hedda, a pure bred Toggenburg, two years old, produced 1118.0 pounds of milk containing 40.7 pounds of fat.

The New York (Geneva) Experiment Station has tested a few milch goats for infant feeding purposes. One Saanan doe gave 1845 pounds of milk in one year on $15.82 worth of feed,

charging $3 for pasture. This is about 922 quarts, at a feed cost of about 1.7 cents per quart.

The Toggenburg doe, Fanette (Fig. 51), is one of the best known milch goats in America. She produced, in one year, 2680 pounds of milk, or nearly twenty times her own weight. This is more than half as much as the average cow of this country produces. It was enough milk to supply two families with two quarts per day each for a year. It would make about 100 pounds of butter or 268 pounds of cheese. This milk, if sold at 25 cents per quart, would bring $335. In some places goat's milk sells at 50 cents per quart.

Milk Records

Breed of Goat	Name	Wt., Lbs.	Milk
Toggenburg	Fanette	136	2680
Toggenburg	Geneva	127	2158
Toggenburg (half breed)	Delia	104	1283
Toggenburg	Hedda (2 yr. old)	119	1118
Saanan	(at Geneva, N. Y.)		1845

The Nature of the Product.—Goat's milk-fat produces rather an inferior butter, especially in color, body and grain, but the milk is said to be remarkably valuable for feeding delicate infants. Milk for such purpose often sells for 25 to 50 cents per quart. It also serves as a household milk supply, for cooking purposes as well as milk for direct consumption.

Composition of Goats' Milk

Authority	Water	Fat	Casein and Albumen	Sugar	Ash
Renesse	85.50	4.80	5.00	4.00	.70
Landwinth	85.60	4.60	4.80	4.30	
Hoffman	86.19	4.73	3.68	4.50	.90
N. Y. (Geneva Sta.)	87.88	3.82	3.21	4.54	.55

It has been shown that the milch goat will yield a food unit in milk solids fully as economically as a good dairy cow, if not more so, for the feed consumed and has the added advantage in relishing various edible weeds. She also may be pastured on so small a lot or pasture that but for her all of the forage on that area

would have gone to waste. The milch goat is now especially needed about the mill towns of New England and the south, and about mining towns in all sections of the country. The State Experiment Stations of California and Geneva, New York, and the United States Department of Agriculture are studying the question of milch goats.

QUESTIONS

1. What is our oldest record of the use of goats as milch animals?
2. Where were most of the breeds of milch goats in America developed?
3. Why are goats not more used in this country?
4. Compare the dairy type of the milch goat with that of an intense dairy cow.
5. Name and describe the two principal breeds of milch goats.
6. How much milk will a good goat yield?
7. Name the milch goat that now holds the United States Championship for production. How much did she yield?
8. How does the composition of goat's milk compare with cow's milk?
9. For what is it especially valuable?
10. In what regions and sections are goats most needed in America?

CHAPTER XVIII

STARTING A DAIRY HERD

The solution of the problem confronting any young man who contemplates starting a herd of cows to be used for dairy purposes will very naturally differ with local circumstances, but assuming only moderate means and the necessity for getting profitable working stock at the earliest time possible, the following method will generally be found the most profitable:

Foundation Stock.—If the prospective dairy farmer has no animals of any sort and is, therefore, free to select, it is highly important that he bear in mind clearly the thoroughly proven value of the dairy type animal, that is, the one showing capacity for the consumption of feed, with spare and angular form, denoting absence of too great a flesh-forming tendency, with udder and milk veins developed adequately to balance the other parts of the body and an alert temperament and good constitution. The purchaser should not overlook the fact that the qualities desired are more likely to be found and far more likely to be transmitted to future workers if grades of some of the standard dairy breeds are selected.

The prospective dairy farmer who already has on hand a herd of good, fair, and indifferent grades of no particular breeding, should bear in mind first, that it is a very poor cow indeed which is not better than no cow at all on the farm; that cows vary tremendously in their ability to return profit, and that life is too short to make it wise to plod along with the inferior cow any longer than is necessary to secure animals of higher quality. Working on this basis, therefore, the one starting in the business with a mixed herd of unknown quality should keep the animals he has until such time as he has good evidence to prove that certain members of the herd should be disposed of and raise his stock from the better half of the herd. To improve such a herd a strong-blooded bull of the breed desired should be placed at its head.

The Jersey cow, if well handled, will produce butter fat more cheaply per pound than any other breed in America, but being sensitive to treatment and best adapted to a moderate climate she requires comfortable housing. When such is provided, however, the Jersey may be kept in any agricultural region.

The Holstein cow ordinarily yields more fat and a much greater amount of skim milk. While it is true that the cost of producing a pound of fat is higher than with the breeds yielding a richer milk, it is likewise true that the skim milk has high value on the livestock farm. The animals of this breed are rather better adapted to withstand the conditions practically certain to obtain on farms where the field operations are of first consideration. The Holstein animals work in exceedingly well on those farms which produce grain and hogs as well as cream or butter for the market.

The Guernsey and Ayrshire breeds have their peculiarities, as explained in the chapters on those breeds, and which fit them for particular niches. The temperament and sentiment of the individual farmer certainly are of importance in the choice of a breed, but in the opinion of the writer these more or less sentimental facts should be subordinated to the adaptability of the breed to the climate, to the type of dairying to be carried on, and in practice to the majority sentiment of the neighborhood. It is being everywhere clearly demonstrated that animals of all breeds have developed not only greater individual qualities in those communities where a goodly number of that breed is kept, but that they also have greater market value per unit of quality. The individual cows of a Holstein herd, for instance, located in a Jersey neighborhood would not have the market value that the same animal would if surrounded by animals of their own breed. The same is true of all the other dairy breeds when too widely scattered.

Selection of the Bull.—In starting a herd of working dairy cows there is probably no single problem of greater importance, nor one which offers greater difficulties, than the correct selection of the herd bull. With a herd of low-producing animals in the hands of an owner of limited means, it is not infrequently

wisest, and in the long run most economical, to purchase a high grade bull, not any high grade, but one which shows the breed characteristics strongly, has individual vigor and constitution and is from a high-producing dam. The fact that cows with which he is to be mated can never produce stock for registration makes it entirely immaterial whether the sire has "papers" or not. The use of a grade sire is not recommended on cows of higher development and not where pure animals may be purchased at reasonable figures. Frequently second-hand, pure bred bulls may be purchased at beef prices. Young animals, especially of the Guernsey breed, are occasionally sold cheaply because of having a "smoky" frill about the muzzle, or having more or less dark hairs about the head and throat. This is supposed to indicate partial reversion to some prehistoric ancestor and since it is not the color desired in the modern breed such animals do not become show animals themselves, nor are they likely to produce such. Some of the strongest working blood of the breed, however, are characterized by this off-color. Farmers desiring pure Guernsey stock to work upon a grade herd will do well to look for such animals. Pure bred Holstein bulls are occasionally pure white and can therefore not be registered. Such would mate well with a herd of red and white grades.

It is agreed that the points to be looked for in selecting an animal are constitution, thrift, masculinity, and trueness to breed type, or in other words the individuality of the animal (Fig. 55). The next point, one which some breeders would put first, is the matter of record or power of performance on the part of the dam and granddam, and as many other generations back of this as possible. Such an animal then in addition to having the prepotency of pure blood will have the strong individuality, or what may be termed personality, which will increase the likelihood that his daughters will resemble his mother and grandmother in ability to produce abundantly. A goodly number of instances are on record indicating that some sires have possessed such wonderful prepotency as to have almost unlimited value, while other animals have done positive harm under the same or similar conditions.

The ideal pedigree must show performance as well as mere relationship. The following Guernsey pedigree is considered a good one in this respect:

Larger records have been made than those indicated in the pedigree, yet those are good, and the fact that uniform high milkers are on both sides increases the likelihood that the progeny of May King of Linda Vista will be strong, consistent producers.

Fig. 55.—Starlights Excelsior of Jean Du Luth, a champion Guernsey bull. A very promising type to use as head of a herd. (Courtesy G. P. Grout, Duluth, Minn.)

Community Breeding.—One income from the keeping of pure bred cows is the increased amount of milk, butter and by-products obtained from them, but a second profitable source of revenue is the sale of breeding stock. At present there is a good healthy demand for more livestock to be shipped into the northwest section of the United States and western Canada. Farm conditions in these regions call for cattle. Those communities in which there are a goodly number of animals of any recognized breed are finding more ready sales at high prices for surplus stock than those individual breeders more or less scattered.

The Ideal Pedigree

MAY KING OF LINDA VISTA No. 17946. First prize and champion bull North Dakota State Fair, 1913. Headed first prize herd Grand Forks Fair, 1914, in strong competition.

- **Sire: Langwater May King No. 13001.** A. R. Herd bull at Anna Dean Farm. $3,600.00 was paid for him. Sire of 3 A. R. cows, including Rosabel of Linda Vista, 547.7 lbs. fat, Class F; Moss Rose of L. V., 500 lbs. fat; Sister May of L. V., 423 lbs. fat in Class G.
  - **Imp. May Rose King No. 8336 A. R.** Ten of his daughters averaged 676.9 lbs. fat. Leading sire of 600 lbs. fat cows. Fashion Plate, 667 lbs. fat; May Rose Queen, 667 lbs. fat.
    - **Itchen Jewel No. 1124 P. S.** Sire of Royal Rose of Easton, 517.8 lbs. fat.
      - Loyal of the Huguenots A. R. Sire of Itchen Beda, 548.7 lbs. fat.
      - France V A. R. 388 lbs. fat.
    - **May Rose II No. 3251 P. S.** First over England for several years. (Foundation cow of May Rose Family.)
      - Pharaon No. 43 P. S.
      - May Rose No. 1392 F. S. Prize winner.
  - **Imp. La Belle Petite No. 18114.** A. R. 547.8 lbs. fat. Dam of Langwater Dorothy, 781 lbs. fat. (The second in class D)
    - **Imp. Masher's Sequel.** Sire of 51 A. R. cows, including Pride II of the Marais, 690 lbs. fat.
      - France's Masher II No. 7218 Sire of 12 A. R. cows.
      - Imp. Lena No. 14015
    - **Imp. La Belle Francesca.** A. R. 388 lbs. fat.
      - Masher No. 705 P. S.
      - La Belle France Dam of 3 A. R.
- **Dam: Queen of the Roses No. 24999.** A. R. 604 lbs. fat at 3½ years old. Record 852 lbs. fat.
  - **Imp. May Rose King No. 8336.** Sire of 19 A. R. cows, including: Rosa Rubra, 788 lbs. fat; Florham Daisy, 747 lbs. fat, and others of note. Sire of 9 A. R. cows, over 600 lbs. fat.
    - **Itchen Jewel No. 1124 P. S.** Sire of Royal Rose of Easton, 517.8 lbs. fat.
      - Loyal of the Huguenots
      - La Belle Francesca A. R. 388 lbs. fat. Foundation of the France Family.
    - **May Rose II No. 3251.** First on the Island and at leading English shows.
      - Pharaon No. 43 P. S.
      - May Rose No. 1392 F. S. Prize winner.
  - **Imp. Grace of Lilyvale No. 18915.** Half sister to Itchen Royal Rose, 497 lbs. fat; Itchen Spot II, 444 lbs. fat
    - **Golden Secret No. 1314 P. S.** Sire of Langwater Lily, 427 lbs. fat, and 4 others. Grand sire of champion cow in class G.
      - Columbia Sire of 3 in A. R.
      - Rose of Gold Championship winner.
    - **Grace of Lilyvale No. 4881 P. S.** Half sister to Violet of Lilyvale II, A. R. 417 lbs. fat.
      - Columbia Sire of 3 in A. R.
      - Dame Polly I No. 4087 P. S

Many communities throughout the country have almost unconsciously, and certainly without concerted action, raised so many animals of the same breed that the farmers are now reaping the benefit very positively. So keen is the demand now for improved livestock and the advantage to the buyer of being able to select a dozen or a carload in one community that in a large number of places the farmers are organizing coöperatively to produce more desirable stock in greater quantity.

Community Breeding Associations.—Organized, well defined efforts have the advantage over the old system of encouraging each man to act independently, while the community drifts, in the following respects:

First. A larger number of improved animals are secured in much less time. The years required to raise, develop and try out a cow are about 10 per cent of the farmer's working lifetime.

Second. Where a dozen or more of the best farmers in any neighborhood lead off in breeding definitely they become more keenly interested in their livestock, take better care of the animals and, through the fact of better care, derive an additional income.

Third. High class breeding sires may be purchased for less money per man when purchased for community use. The economy also is increased, because when the sires have worked a period of two years in any community they may be systematically exchanged with little loss.

Fourth. The surplus grade stock not only rapidly takes the place of the older cows, but also accumulates in such number as to attract outside buyers. Another advantage noticed is that the farmers who begin the matter of improvement in one line of stock seldom are satisfied until all the classes of livestock and field crops too have been studied for the purpose of improvement.

The great advantages of á comparatively close organization over the looser methods of conducting this business may be briefly summarized as follows: A well organized committee attracts farmers' institute speakers and other community workers. Thus the individual members have greater opportunity than they

would likely have otherwise. The national and state associations representing the breed kept are more likely to send literature and lecturers. Another feature occasionally found highly valuable is in the control of the character of the deals made by some of the members, where the association guarantees stock sold and expels members selling animals of known sterility or with a disease. Such has been found excellent advertising and highly profitable to the farmers of the community.

Disadvantages of Community Breeding.—Probably the greatest single drawback to community effort is the possibility of introducing and disseminating diseases, most particularly, infectious abortion. Though this fact should be borne in mind continually in purchasing and in exchanging sires, those communities which have for five or more years carried on work of this sort have not experienced serious difficulty. The inconvenience and loss of time entailed in taking a cow some distance for service are sufficient to deter some from joining the association though often owning animals of the same breed. In some communities exchanges are made between the individual and the associated breeders. The individual ownership of bulls has its advantages. There is nothing to prevent the two systems working in harmony in the same community. The object especially is to increase the number of high class animals as quickly as possible without great expense and then the organized selling of surplus stock.

Selection of the Individual Cow.—It must be ever remembered by the breeders of livestock that the laws underlying reproduction are at best but poorly understood and difficult of control. After all the care has been taken which would seem possible or wise, individual members of the herd will, for reasons apparent or obscure, fail to develop into sufficiently profitable cows. The wise dairymen will watch for these variations, both that he may eliminate the inferior, and that he may increase his herd from the most valuable animals.

Variation is opportunity for progress, but the inferior individual must not be used as a propagator of others or the opportunity will be lost. While the causes of variation are obscure, the fact of variation is evident.

Daily Records.—Farmers have for years been advised to keep daily records of the quantity of milk produced by their cows and to test sufficiently often to know approximately how much fat is being yielded by each cow. The system entails considerable attention and some labor, but where given a fair test is found to be a paying investment. The form of the record sheet used for such is similar to the sample shown. This record is designed to accommodate twenty cows for a week but may be extended to include the production of a month if desired. The form here shown is that adopted by the Dairy and the Extension Divisions in the University of Minnesota. The complaint is often made that to weigh the milk twice a day consumes so much time that more is lost than gained in the process. This criticism, however, is made by those who have never tried it. The advantage of sytematically weighing every milking over a period of three days a month is that in addition to determining the production of the cow the added value of having what may be termed a thermometer of the business is at hand. Many items, such as scarcity of water in the pasture, short, dry grass, presence of flies, bad hay, cold rains, or poor milkers, have a decided influence upon the profitableness of the dairy enterprise, yet may not be noticed for a week or more unless there be at hand a record of production. Some cow keepers have continued the daily records after becoming convinced that all the cows in the herd are profitable, purely for the effect of rivalry created among the milkers.

A sheet summarizing by months the work done by the cows for the year will be found highly advantageous. Sample of the sheet used in Minnesota for this purpose is shown on page 146.

Three Day Records.—At times the labor involved in daily weighing seems so great that the farmer decides not to commence testing. To such the system of weighing the milk on the middle three days of each month is recommended. The yield for the month is calculated by multiplying by ten the yield for the three test days. This system requires scarcely 10 per cent of the labor involved by the daily weighing system and its accuracy is found to be about 96 per cent. This is more accurate than usual records kept of other farm operations. Where the fat test is made

MILK AND FEED RECORD

THIS SHEET IS PLANNED TO BE USED AS A WEEKLY RECORD WHEN EVERY MILKING IS WEIGHED. IT MAY BE USED AS A MONTHLY RECORD IF ONLY OCCASIONAL MILKINGS ARE WEIGHED, AS INDICATED IN NOTE BELOW.

HERD OF ______________________ FROM __________ 19__, TO __________ 19__

COW-NAME AND NUMBER →		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	REMARKS.
DATE		lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	lbs. 10ths	
	A.M.																					
	P.M.																					
	A.M.																					
	P.M.																					
	A.M.																					
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	A.M.																					
	P.M.																					
	A.M.																					
	P.M.																					
TOTAL																						
GRAIN																						
ROUGHAGE																						

Kinds of Grain Fed:	Parts in Mixture	Price	Kinds of Roughage	Price
Ave price per lb.				

IF MILK IS NOT WEIGHED EVERY MILKING, WEIGH AT LEAST MORNING AND EVENING ON THE 1ST., 10TH., AND 20TH. OF EACH MONTH.
AN INDIVIDUAL COW RECORD FOR BOTH THE MONTHLY AND YEARLY SUMMARY IN PAMPHLET FORM IS USED WITH THIS SHEET. BOTH CAN BE SECURED BY ADDRESSING THE BOOK STORE, UNIVERSITY FARM, ST. PAUL

from a sample composited from the six milkings there is no reason why this system should not be fully as accurate as those now in vogue with most of the pure bred cattle associations in the making of semi-official yearly records, where the herd is visited only two days each month by the official representative.

The three-day system of record keeping is best carried out by ruling a cheap day book. The books recommended are those about five inches wide by a foot long, and cost 10 cents. The

YEARLY SUMMARY.

HERD OF MINN. FROM 19 , TO 19

NAME OF COW	No.	BREED	AGE	DAYS IN MILK	LBS. MILK DURING YEAR	LBS. B. F. DURING YEAR	AVERAGE TEST	AVERAGE PRICE BUTTER FAT	VALUE OF BUTTERFAT	COST OF FEED CONSUMED					RETURNS		REMARKS.
										GRAINS	ROUGHAGE	SUCCULENT	PASTURE	TOTAL COST OF FEEDS.	ABOVE COST OF FEED	BELOW COST OF FEED	
	1																
	2																
	3																
	4																
	5																
	6																
	7																
	8																
	9																
	10																
	11																
	12																
	13																
	14																
	15																
	16																
	17																
	18																
	19																
	20																
TOTAL																	
AVERAGE																	

advantages of this volume are that it is too large to be easily lost, yet sufficiently small to be handled, and when ruled as indicated, one writing of the cows' names will suffice for a year. The book is sufficiently large to contain the records of thirty cows for seven years if desired. It is recommended, however, that in the latter half of the book each cow be given a page upon which are recorded all important events affecting her during the year, such as date of service; date due to calve and trouble, if any. One volume per

year kept in a convenient place in the stable will be found highly valuable and worth many times its cost.

Permanent Records.—It is unwise to keep the permanent records on scraps of paper or in pocket-sized books.

A book of 200 pages, each page about five by twelve inches, can be purchased for ten cents. Each page will hold the record of thirty cows for a month. The names or numbers of the cows should be written down the left margin of the left-hand page, then ruled up as shown below.

The names need not be written on the next page but it should be ruled so that the outer third of the leaf may be cut off, so that when turned it will just fit the names of the cows. Then on this narrow page the next month may be ruled, and so on. In this way one writing of the names will answer for a whole year or longer.

Herd Record for January, 1916

Name and No. of Cow	Lbs. milk given in three days	Estimate of milk per month	Test from composite sample	Lbs. fat per month
1. Bettie	60	600	3.5	21.00
2. Carlton	48	480	3.7	17.76
3. Clara	90	900	3.4	30.60
4. Violet	21	210	4.6	9.66
5. Fay	etc.	...	...	....
6.	..	...	...	....

Dairy Testing Associations.—In 1905 the first coöperative association in the United States of America for the testing of cows was organized in Michigan. The idea and the individual organizing the first in the United States came from Denmark. The plan is that twenty-five farmers join their interests in the matter of testing and calculating dairy rations. In sections of the country where herds are comparatively large one dollar per cow per year furnishes money enough to run the association. In the middle west dairy herds are smaller on the average, and $1.25 to $1.50 per cow per year is necessary, since only those cows belonging to approximately twenty-five farmers can be tested. The system is to employ a competent young man, usually a graduate of a school of agriculture, or a short course,

to go from farm to farm to weigh and test the milk; weigh old rations fed and compute new. He remains but one day in a place, making the circuit once each month. Whenever a good tester is obtained, experience shows the investment to be a highly profitable one on the farmers' part. Aside from getting the work done more cheaply than the farmer himself could usually do it there is the added advantage that it is done, which is so likely not to be the case for more than a few months, if the work is left entirely to the owner who has so many other matters demanding mental and physical attention.

The three requisites for improvement in livestock are breeding, feeding and selection. The dairy herd is no exception. A constant culling out process is essential to improvement.

Some Results of Cow Testing.—The nature and the amount of improvement which coöperative testing associations may be the means of effecting are shown in an average of ten herds in one Iowa association during four years, as follows:

Year	Avg. animal milk yield per cow Lbs.	Avg. animal butter fat per cow Lbs.	Avg. animal feed cost per cow	Avg. animal profit per cow.
1911	6483	246	$26.40	$32.42
1912	7649	277	52.31	39.20
1913	8738	285	43.67	52.95
1914	8648	312	48.12	66.02
One single herd increased	Lbs.	Lbs.		
1912	5665	207.7	$43.77	$22.12
1913	7060	251.9	33.28	53.96
1914	9679	339.8	46.12	72.22
1915	10184	369.6	52.28	74.38

Similar improvements have been brought about in a great many herds and communities.

The growth and status of the work are well shown by the following table compiled by the Dairy Division, United States Department of Agriculture, Washington, D. C.

Number of Coöperative Cow-Testing Associations in the United States, In Operation on July 1st, Each Year

States	Number of Associations in operation									
	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915
Michigan	1	4	2	5	4	3	4	4	3	3
Maine	.	.	3	4	3	6	5	4	5	8
New York	.	.	1	1	3	9	18	21	29	35
Vermont	.	.	.	2	8	10	11	17	28	33
Iowa	.	.	.	2	5	4	8	7	8	13
California	.	.	.	1	3	2	4	4	5	7
Wisconsin	.	.	.	9	10	10	8	11	24	37
Nebraska	.	.	.	1	0	0	0	3	2	3
Colorado	.	.	.	.	1	1	2	1	1	0
Pennsylvania	.	.	.	.	1	1	2	2	7	14
Ohio	.	.	.	.	1	0	0	1	4	5
Maryland	.	.	.	.	.	1	3	3	2	4
Illinois	.	.	.	.	.	4	3	2	7	3
Washington	.	.	.	.	1	3	1	0	0	1
Minnesota	.	.	.	.	.	3	7	10	9	11
New Hampshire	.	.	.	.	.	1	1	1	4	8
Oregon	.	.	.	.	.	1	1	1	7	11
Utah	.	.	.	.	.	1	0	0	1	1
Massachusetts	.	.	.	.	.	2	2	2	3	0
Virginia	.	.	.	.	.	2	2	2	0	0
Kansas	.	.	.	.	.	.	.	1	1	1
Indiana	.	.	.	.	.	.	.	2	2	3
Kentucky	.	.	.	.	.	.	.	1	1	0
Missouri	.	.	.	.	.	.	.	.	2	1
New Jersey	.	.	.	.	.	.	.	.	2	3
West Virginia	.	.	.	.	.	.	.	.	1	1
Connecticut	.	.	.	.	.	.	.	.	1	3
North Carolina	.	.	.	.	.	.	.	.	2	0
Louisiana	.	.	.	.	.	.	.	.	1	0
South Dakota	.	.	.	.	.	.	.	.	1	1
Nevada	.	.	.	.	.	.	.	.	.	1
Total	1	4	6	25	40	64	62	100	163	211

QUESTIONS

1. Give suggestions regarding the foundation stock for a dairy herd.
2. In your section what blood predominates in the dairy herds?
3. What are the points of a good dairy bull?
4. Give important points of a good pedigree.
5. What is meant by community breeding?
6. Give advantages and disadvantages of a breeding association.
7. What dairy records should be kept by all dairymen?
8. Of what use are these?
9. Compare the three-day record with the daily record.
10. What is a dairy testing association? Explain its working.
11. What are some of the results of such associations?

PART III

CARE AND MANAGEMENT OF DAIRY COWS

CHAPTER XIX

DAIRY HERD MANAGEMENT

Motherhood and mother-love are the very foundation of the dairy industry. When a man comes to look upon a cow as a mother, a calf as a baby and young stock as growing children, he is in a very fair way to learn how to handle them.

The great force which impels or stimulates milk production is the fact of motherhood, or, more exactly speaking, probably an enzyme formed in connection with motherhood. If this stimulating force be strong the cow will convert the nutriment contained in her feed into milk more rapidly, and keep at it for a longer time than she could if this stimulating force were weak.

We do not yet know what organ of the body secretes this stimulating fluid nor how to test for it in advance. We can only wait and see what the cow does under good care and feeding and then judge her in comparison with other cows.

The largest single item in the production of the recent phenomenal milk records of all breeds is without doubt the better methods of handling now employed (Fig. 56), but next to this seems to be the inherited presence in some families and individuals of an unusually strong secreting power.

This may explain, in a way, why some cows of good constitution and general type are, after all, very commonplace producers, and also why a cow of non-famous family occasionally springs into prominence by making an unusual record. The law of variation in breeding may have passed on to her this mark, just as Jerseys of solid-colored parents are born with spots or Guernseys of orange and white parents with solid color or with dark " smoky " hairs about the muzzle, neck, or rear.

Without in any way minimizing the value of breed, or type of the cows employed in the dairy, or the great importance of the ration consumed by the cows, it should be remembered that in the detailed management of the herd lies a very large part of the profits or disappointments to be derived. Excellent cows

can be liberally fed, yet so handled as to produce little or no profit. The common cow may be handled so as to increase her production from twenty-five to fifty per cent over present yields.

Gestation Period.—The length of time between service and the delivery of the calf is usually 280 to 285 days, or a little more than 9 months. It averages a little longer for bull than for heifer calves. In order that the cow may be dried off at the right time it is necessary that record be kept of the date of service of every cow.

Time to Freshen.—Under most conditions in the United States, cows should be bred to freshen in the fall; the calves to be dropped between October 1st and January 1st. If rea-

Fig. 56.—Evidence of thrift and faith.

sonably well housed (Figs. 56 and 57), cows are more comfortable in winter than in summer. This saves feed. They likewise travel about much less, which also is economy. These facts enable the cow to yield milk upon less feed in winter than in summer. This becomes the more important when considerable quantities of feed are purchased or where forage crops are raised on high-priced land.

Nature forces the cow to yield milk for at least a few months after calving for the sustenance of its own calf. Thus the cow when comfortably housed, liberally fed and kindly treated may be expected to milk during the entire winter months. After a period of four to seven months most cows begin to slack off in

Gestation Table

Calculated at the Average Period of 282 Days, for Every Day in the Year. The Period is as Short as 269 Days, and as Long as 292 Days

Served	Due	Served	Due	Served	Due	Served	Due	Served	Due	Served	Due	Served	Due	Served	Due	Served	Due	Served	Due	Served	Due	Served	Due
Jan.	Oct.	Feb.	Nov.	Mar.	Dec.	Apr.	Jan.	May	Feb.	June	Mar.	July	Apr.	Aug.	May	Sept.	June	Oct.	July	Nov.	Aug.	Dec.	Sept.
1	10	1	10	1	8	1	8	1	7	1	10	1	9	1	10	1	10	1	10	1	10	1	9
2	11	2	11	2	9	2	9	2	8	2	11	2	10	2	11	2	11	2	11	2	11	2	10
3	12	3	12	3	10	3	10	3	9	3	12	3	11	3	12	3	12	3	12	3	12	3	11
4	13	4	13	4	11	4	11	4	10	4	13	4	12	4	13	4	13	4	13	4	13	4	12
5	14	5	14	5	12	5	12	5	11	5	14	5	13	5	14	5	14	5	14	5	14	5	13
6	15	6	15	6	13	6	13	6	12	6	15	6	14	6	15	6	15	6	15	6	15	6	14
7	16	7	16	7	14	7	14	7	13	7	16	7	15	7	16	7	16	7	16	7	16	7	15
8	17	8	17	8	15	8	15	8	14	8	17	8	16	8	17	8	17	8	17	8	17	8	16
9	18	9	18	9	16	9	16	9	15	9	18	9	17	9	18	9	18	9	18	9	18	9	17
10	19	10	19	10	17	10	17	10	16	10	19	10	18	10	19	10	19	10	19	10	19	10	18
11	20	11	20	11	18	11	18	11	17	11	20	11	19	11	20	11	20	11	20	11	20	11	20
12	21	12	21	12	19	12	19	12	18	12	21	12	20	12	21	12	21	12	21	12	21	12	20
13	22	13	22	13	20	13	20	13	19	13	22	13	21	13	22	13	22	13	22	13	22	13	21
14	23	14	23	14	21	14	21	14	20	14	23	14	22	14	23	14	23	14	23	14	23	14	22
15	24	15	24	15	22	15	22	15	21	15	24	15	23	15	24	15	24	15	24	15	24	15	23
16	25	16	25	16	23	16	23	16	22	16	25	16	24	16	25	16	25	16	25	16	25	16	24
17	26	17	26	17	24	17	24	17	23	17	26	17	25	17	26	17	26	17	26	17	26	17	25
18	27	18	27	18	25	18	25	18	24	18	27	18	26	18	27	18	27	18	27	18	27	18	26
19	28	19	28	19	26	19	26	19	25	19	28	19	27	19	28	19	28	19	28	10	28	19	27
20	29	20	29	20	27	20	27	20	26	20	29	20	28	20	29	20	29	20	29	20	29	20	28
21	30	21	30	21	28	21	28	21	27	21	30	21	29	21	30	21	30	21	30	21	30	21	29
22	31		Dec.	22	29	22	29	22	28	22	31	22	30	22	31		July	22	31	22	31	22	30
	Nov.	22	1	23	30	23	30		Mar.		Apr.		May		June	22	1		Aug		Sept.		Oct.
23	1	23	2	24	31	24	31	23	1	23	1	23	1	23	1	23	2	23	1	23	1	23	1
24	2	24	3		Jan.		Feb.	24	2	24	2	24	2	24	2	24	3	24	2	24	2	24	2
25	3	25	4	25	1	25	1	25	3	25	3	25	3	25	3	25	4	25	3	25	3	25	3
26	4	26	5	26	2	26	2	26	4	26	4	26	4	26	4	26	5	26	4	26	4	26	4
27	5	27	6	27	3	27	3	27	5	27	5	27	5	27	5	27	6	27	5	27	5	27	4
28	6	28	7	28	4	28	4	28	6	28	6	28	6	28	6	28	7	28	6	28	6	28	6
29	7	29	8	29	5	29	5	29	7	29	7	29	7	29	7	29	8	29	7	29	7	29	7
30	8			30	6	30	6	30	8	30	8	30	8	30	8	30	9	30	8	30	8	30	8
31	9			31	7			31	9			31	9	31	9			31	9			31	9

production. If at this juncture the spring arrives with its warm weather and succulent appetizing grass, the milk flow is greatly stimulated. These and other forces cause the cow to increase in milk flow in spring often nearly equal to the maximum produced shortly following freshening. Later, as the pasture grows short and the grass tough and heat and flies arrive, the herd will decline in milk flow rapidly, but if the majority of the cows freshened in the autumn previous, they will already have given milk nearly a year. They may be allowed to go dry at this time. They need a vacation anyway.

Fig. 57.—A good general farm and dairy barn. On this farm the author was raised.

The fall-fresh cow will yield about fifteen to twenty per cent more milk in the year than the spring-fresh cows. It is good practice to give them their dry period while the farm work is as pressing as is usually the case in August and September.

Milk and butter fat also bring higher prices in winter than in summer. Thus the cow producing the bulk of her flow at a time when it is worth most per pound becomes exceedingly more valuable than one producing most liberally when prices are low.

The time required to care for the cows may usually be more readily taken in winter than in summer.

Furthermore, since the amount and value of manure produced depends largely upon the kind and amount of feed con-

sumed, it is found that winter dairying serves to produce more manure at a time of the year when it can be saved.

Winter dairying is more profitable than summer dairying, then, because the cow will give more milk, will give the bulk of it when prices are highest and when labor is cheapest, and will produce more manure when it can be saved. In addition, the calf born in the autumn has the advantage over spring-born calves, as noted elsewhere.

Changing to the Fall Basis.—Many cows are still permitted to freshen in early spring. How they shall be put upon the fall basis varies with the individual animals in question, but it will usually be found more economical to force the herd to "back up," in other words, the cow is to be bred as soon after calving as possible, thus causing her to drop the next calf in less than a year from the time she previously freshened. By again breeding quickly it is possible to force the calving period back into the early winter or late fall. If, however, the cow in question be of dairy breeding, and intense dairy temperament, to such an extent that œstrum does not appear for three to six months after calving, it will be practically necessary to breed as soon as possible and to let the calf come when it will. Such animals, however, will be found the most persistent milkers, which will enable them to give milk a year and a half, if necessary. It is much easier to control the time of calving with the Holstein, Ayrshire, or Brown Swiss, than with the Jersey or Guernsey.

Giving the Cow a Rest.—The yielding of two to four pounds of solid feed per day in milk is very exhausting to the cow's system. When to this is added the burden of the growth of the calf, a very considerable amount of work is being done. In order, therefore, that the calf may be amply nourished, and born strong, and that the cow herself may have recuperated in flesh sufficient to enter upon a new lactation period strongly, it is highly advisable that the cow be given a rest of at least four, and better, six weeks. With the majority of cows no special effort need be made to cause them to go dry, but with the high type dairy animal with the intense dairy temperament, there is likelihood that the secretion of milk in considerable quan-

tities will continue until the new calf is born. This is detrimental to the calf and the cow also. Such cows need carefully to be forced to go dry.

Drying Off the Cow.—To hasten the drying process a large part, or all, of the grain may be withheld from the ration, thus forcing her to subsist largely, or wholly, upon roughage. To this inducement may be added that of leaving a little milk in the udder at each milking for a time, that is, not milking out clean and shortly the milking of the cow only once a day. In this way most cows may safely be dried off preparatory to their rest period. To do this intelligently it is highly important that a breeding record be kept.

The dry cow should be looked upon as a prospective milker, not as a mere boarder. If at all run down in flesh, grain or other sufficient feed should be given to enable her to thoroughly recuperate her exhausted condition. If pasture is ample no grain will be needed, but she should not be allowed to approach the next period of exhausting labor in a thin or indifferent condition. In fact it is now considered good practice and economy to feed some grain, if need be, while the cow is dry in order that she may become well recuperated, in fact almost fat. Enough more milk with a higher test will be produced during the next lactation period amply to repay the expense of conditioning at this time.

Preparing Cows for Record Making.—Since milk fever is now little to be feared it has become the custom to "condition" or partially fatten cows during the dry period in order to enable them to produce a materially greater amount of milk and fat immediately following parturition. It has for years been known to a few, and more recently made generally public, that not only will a cow in good condition produce more milk, but that she will also yield milk of a somewhat higher fat content while milking down than would be the case if she had freshened in a lean condition. Thus, some Holstein cows, while weighing 1400 pounds, yielded milk testing close to five per cent fat and so much of it that they were unable to eat enough feed to maintain such a large flow of rich milk. Consequently body tissue was drawn upon. The cows became thinner day by day.

As the body fat disappeared the percentage amount of fat in the milk lowered until as the cow, after a period of a few months, reached her lean working level, the percentage of fat in the milk had dropped gradually to about 3.25 per cent. The Holstein cow, Missouri Chief Josephine, averaged a test of 4.04 per cent fat during her seven-day record, but fell to only 2.81 per cent as an average for the year. Feeding during record making is discussed in Chapter XXIII. To prepare the cow to make the largest seven-day or thirty-day or yearly records, therefore, it is essential that she be given a rest period sufficient for thorough recuperation, even to become moderately well covered with fat.

A caution here is due. If the high-milking cow is fed grain up too close to her calving time there is danger of inflammation of the udder. This is particularly the case if corn forms a large part of the grain ration. All grain should be withheld several days prior to calving, and succulent roughage, as corn silage or roots, be fed in moderation. This is done in order that her system shall not contain too much feed material and that her bowels shall be loose at the time of the birth of the calf.

Manure an Index in Feeding.—Any careful herdsman of cows, horses, or other stock, will notice the condition and odor of the manure. If too hard the animals need some loosening feed, if too loose, some dry feed will usually help. The odor should also be noted. If it has a strong, rotten odor, evidence is ample that the animal is out of condition, most likely from over-feeding, and is not digesting her feed. Such putrid odor indicates that the whole system of the cow is being poisoned. In such a case a good dose of physic to clean out the fermenting matter should first be given and followed by a lessened amount of feed. Undigested kernels of grain usually call for finer grinding of the grain feed.

Milking Before Calving.—Occasionally it is necessary to milk the cow partially before the calf is delivered. This should not be done, however, unless the udder becomes severely distended and painful, and then in quantity only sufficient to relieve the stress. Most cows do not require this precaution. With high-

class cows one danger in milking before the calf is born is the likelihood of bringing on milk fever.

Care at Calving.—The calving period is a critical one in the cow's life. Our domesticated animals are very liable indeed to produce young so large as to require assistance in delivery and other calves of normal size occasionally become misplaced and demand attention to prevent suffocation. Cows in pasture still follow their wild instincts to hide in a remote corner, to calve in secrecy, and even to hide the young in the tall grass or brush. Cows freshening in the early winter are, therefore, much more easily cared for at this time. When nearly due to freshen the cow should be put in a box stall sufficiently large to allow free movement and turning without danger. Abundance of water and a little coarse succulent feed should be supplied (Fig. 58). Attention should be given that her bowels are moderately loose. The herdsman should be near at hand at the moment of calving to give assistance if needed. A few minutes spent at the critical moment may save the life of a valuable calf and occasionally the cow's as well.

Care After Calving.— The strain upon the cow's system due to calving brings on some fever and nervousness. She should be given free access to water which is not too cold. No feed need be given for some hours. If both cow and calf are normal they may be left alone, she to clean and to lick the calf off, and he to learn the use of his legs. The cow is usually permitted to suckle the calf once, though this is not necessary. Cows have strong attachment for their calves only after having lived with them for a few days. Consequently, the removal of the calf at once, or when but a few hours old, causes no particular bereavement on the part of the cow. The calf is wholly forgotten in a day. The calf should be removed from the sight and hearing of the dam while she is absent from the stall. Her return is the psychological moment for the dairyman. The man who later is to milk her should be on hand to caress, to speak kindly and to feed a moderate mess of steamed oats or bran mash. While she is consuming this delicacy the herdsman should groom her

with a brush, handle the udder and teats, and gently draw a small quantity of milk. It is not at all infrequent for the cow to transfer her affections from the calf absent to the man present, to adopt him as it were, and to him yield milk as freely and as gladly as she otherwise would have done to her own young. The more intelligent and sensitive the cow and the man, the more keenly true these facts.

Milk Fever.—The disease known as milk fever, or parturient apoplexy, which was the dread of high-class dairymen for a good many years, is no longer much to be feared, for whatever may or may not be the real cause of the condition, its cure or

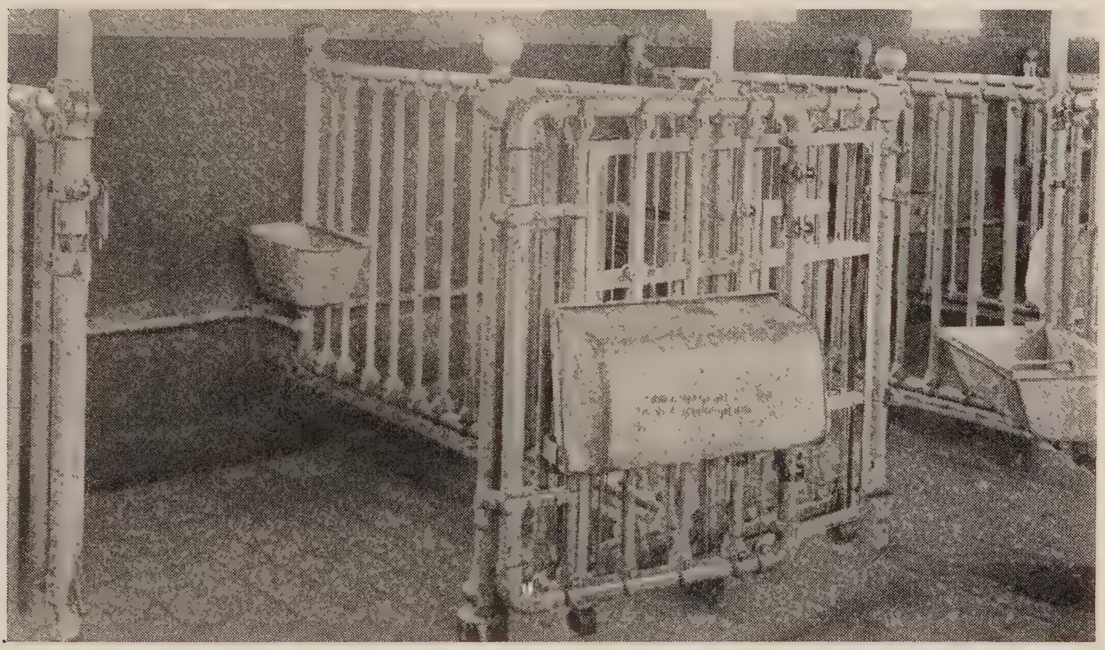

Fig. 58.—A supply of good water constantly within reach of the cow is an aid in milk production. (Courtesy James Mfg. Co.)

prevention is now not difficult and reasonably certain by means of the so-called air treatment.

To prevent this malady so far as possible the heavy milking cow should not be fully milked out at first nor for a couple of days. The precipitation of the condition is closely associated with the sudden and complete removal of the contents of the udder. By removing the first milk gradually many mishaps may be averted. Occasionally, however, precautions fail to prevent and the cow comes down with milk fever. For treatment, see page 202.

Two or More Milkings Per Day.—Ordinarily the cow milked twice per day, dividing the twenty-four hours into two approximately equal periods, will give as much as she would if milked three or more times per day. The fact remains, however, that when the udder becomes filled with milk there seems to be a cessation of the activity of the milk secreting glands. Some cows are able to digest and to convert into milk a quantity of feed considerably greater than can be stored in the udder when removed but twice daily. Such cows should be milked three times and most abundant milkers four times per day, dividing the twenty-four hours into eight or six hour periods, as the case may be. This naturally involves more labor, but if a large yield is sought, such care will be found necessary. The phenomenal records recently made by the leading cows of all the various breeds were produced upon the system of three or four milkings per day.

Period of Greatest Yield.—As a rule cows give the most milk per day between the eighteenth and the twenty-eighth day after calving. The most fat is usually produced during the second week and the most milk during the third week. This then would be the time for expecting advanced registry records to be made if any were possible.

Breeding.—Following a normal calving, a cow should not be bred for about three months, unless it is desired to turn the time of calving to an earlier date; but following an abortion the cow should be bred as early as conditions will permit. That is as soon as all discharges have ceased and all organs are clean and healthy again. The disease which causes abortion also induces sterility, consequently, considerable time may elapse before conception will take place. It is wise, therefore, to start early in order that the cow may not lose any more time than necessary.

The first year's record of a young cow, according to Eckles, may be used as a guide as to her ability to perform in later life, providing, of course, she is not too young when beginning work and has been adequately fed and housed. A dairy breed heifer freshening at twenty-four to twenty-eight months of age should produce during the coming year about 70 per cent of the

quantity which would be expected of her in her mature form and during the second lactation year 80 per cent and the third 90 per cent.

One should not draw too hasty conclusions regarding a young cow that is not doing well yet which is of such breeding that better work might be expected.

The famous Holstein cow, Missouri Chief Josephine, calved the first time when about two and one-half years old and was fairly well fed after she calved but had not been put into condition before freshening. Her milk for the first three months tested only 1.5 per cent fat. Her first year's work was very ordinary, but upon maturity and with better feeding she broke the world's record for six months, producing 17,008 pounds of milk. Her record for the year was 26,861 pounds of milk. On her best day she yielded 110.2 pounds of milk, about fifty quarts, testing 2.8 per cent fat.

Effect of Feed on Test of Milk.—When cows have for a considerable time been very inadequately fed they not only will produce a smaller quantity of milk and fat, but the milk will have in it a slightly lower percentage amount of fat. The same animals later liberally fed upon the ordinary feedstuffs are known to increase very materially not only in total quantity of milk and fat yielded, but also in percentage of fat as well. Many reasonable and other methods have been tried for the production of milk of higher fat content. Such artificial methods as the feeding of fat, however, produce a higher percentage only by throwing the cow out of condition and making her feverish. The period of high percentage fat is then of short duration and is usually followed by a period of depression.

The only practicable way of securing more fat for market is by feeding the cow liberally, yet within reason, on a balanced ration made up of ordinary feedstuffs and otherwise giving her such care that she will be able to yield a larger quantity of milk. The struggle to secure a higher fat content in milk is impractical with any cow except in so far as it can be influenced by the condition of body fatness accumulated during her period of rest; or as a long time plan, the breeding from stock which

yields milk of a fat content higher than the average for the breed.

The effect of drought on the richness of milk is to lessen it perceptibly, especially if the drought occurs early in the season, before the grass has become fully grown or matured. In 1906 an early drought in northern Missouri caused the fat test of milk to decline as much as five-tenths per cent or from 3.7 to 3.2. The solids not fat in the milk were also so low that the lactometer reading of such milk was as low as 28 or 29 with grade Shorthorn cows, when it should and normally would have been 31.5. The yield of cheese as well as of butter was disappointingly low during that season.

Effect of Turning on Pasture.—One of the traditions of the dairymen is that the quality of milk depreciates when cows are turned from the dry feed of the stable on to the succulent spring pasture. They were often encouraged in this belief by local creamery men during the days of the whole milk creamery. That there is no uniform decrease in the fat content of milk under such conditions is proved by the thousands of tests made of milk at the Minnesota Station. At this institution a sample of every milking is tested by itself, not composited, as in so many places. For more than twenty years, with a herd varying from twenty to sixty cows, tests have been made twice a day. The breeds included in this and other experiments included the Jersey, Guernsey, Holstein, Ayrshire, Shorthorn and Brown Swiss. From the mass of evidence at hand it may be stated that the usual opinion is incorrect where well-fed cows are concerned that, whereas a few decrease in fat content, the average test of the milk of the well-fed herd is greater following the turning on to pasture than it was just prior to it. It is highly probable that the impression gained a place during the pioneer days when cows "spring poor" were often turned out to pasture long before there was enough feed even to sustain weight, to say nothing of producing milk.

Large vs. Small Pasture.—A small pasture with an abundance of grass is economical, in that the cows do not waste so much of their energy in travelling about. On the other hand, a study of the movements of the herd in pasture will reveal the

fact that they choose location according to the condition of the weather, seeking the sheltered places if chilly, while resting on the hill-top in hot weather. A large pasture offers greater opportunity for the cows to make themselves thoroughly comfortable. If, however, the pasture is on a dead flat prairie country it is probable that the smaller pasture is preferable, while on rolling or broken land, the larger is better.

Acres Required Per Cow.—This naturally varies greatly with the fertility of the field and the rainfall, also in many sections with the amount of timber or brush land included in the pasture. Dense forest yields little pasturage. Likewise in old clearings, largely grown up to brush, grass is to be found only in the open spaces, while within the clumps of bushes little or nothing can be secured by cows. The open field, well seeded to blue grass and white clover, will, on the average, yield grass in such quantity that two to three acres will feed one mature cow during the pasture season. The rotation pasture, however, should produce more feed and thereby require only about one and a half acres per cow per season. In many sections it is calculated that the average young stock consumes one-half and the dry cow two-thirds as much feed as the cow in milk. This distinction is made for pasture rental purposes.

Short Pasture.—It is highly probable that the great dropping off in milk flow in July and August is due more to the short, dry pasture than to the presence of flies. The writer once tested this matter by means of two groups of cows similarly fed, one-half turned to pasture and the other half kept in the yard. Both were annoyed with flies about equally and both had all the feed they would readily consume, yet those animals that went to pasture went dry at the rate of 15 per cent per month, while those kept in yard decreased at the rate of only 8 per cent per month. If to the quiet of the yard had been added the comfort of a half-darkened stable during the day the difference between the two groups would unquestionably have been yet more marked.

If we will but remember that the average cow, giving the average amount of milk, requires the feed nutrients contained

in about 100 pounds of grass per day, and will then calculate the number of steps and bites the cow must take on a short pasture to secure 100 pounds, it will readily be believed that she does not continue to labor until the full amount has been obtained, but rather that when the hunger is fairly satisfied she ceases her search and lies down to rest. She has probably already walked a greater distance than is really good for her and yet has secured an insufficient quantity of feed. Her maintenance then would be above normal and the supply of feed below normal, thus reducing the quantity of feed consumed beyond maintenance, to an exceedingly small amount.

Protection Against Flies.—The amount of harm done the dairy herd by annoyance from flies is not at all a settled matter. Two experiment stations, Connecticut and Missouri, conducted tests to indicate the influence of the fly and, entirely independently of each other, came to the conclusion that the damage done by the fly had been overestimated and that the slacking off in milk yield was due far more largely to a scarcity of feed and short pasture. On the other hand, we find experienced and keenly observing dairymen who attribute the falling off in milk during fly season very largely indeed to the labor and pain endured by the cows due to the flies. This is particularly the case in some of our newer northern sections where various "deer," "moose" and "night" flies are particularly abundant.

It is possible, therefore, that the difference of opinion is in part due to the difference in the sort of fly common in the section considered.

Supplementing the pasture by means of a crop (of Canadian field peas and oats) to be cut and fed green when pastures are short and dry, is often necessary in the maintenance of milk flow. If this is contemplated, about one acre should be used for every twenty cows to be fed. Canada field peas and oats sown as early as the ground can be worked, and followed by a similar quantity sown when the first has grown to a height of two or three inches, makes a good soiling crop for the northern states. A more reliable crop to be fed later in the season will be found in fodder corn, drilled thickly, at the rate of thirty-five to forty

pounds of seed to the acre and put in as early as the season will permit. This will be ready to feed in seventy-five to ninety days after planting. If possible, the field of corn to be fed out, should be located close beside the pasture or even enclosed within the pasture. This nearness is for the sake of ease and economy of labor in feeding. A few minutes with a hand corn knife will suffice to cut and throw over the fence as much as the animals will readily consume. If the supplementary corn field is located by the pasture and is made long and narrow the expense of feeding will have been reduced to the minimum and it will be found to be a wonderfully well paying investment.

Milking.—The cow is a creature of habit. To return the maximum of milk for the feed consumed she should be milked at regular intervals, and preferably, by the same individual. In some institutional or other large herds where the milking force is continually changing in personnel, thus necessitating frequent change of milkers, it is found preferable to shift the milkers continually in order to prevent any cow from becoming attached to any one milker. Thus the operation of milking becomes an impersonal matter. It is more likely, too, that the damage done by an individual poor milker will be partially rectified by the following good milker.

In beginning the milking act care should always be taken to start the process slowly. Sharp pains unquestionably pierce the cow's udder just as the milk starts. The first few streams should be taken slowly and gently, especially in cold weather. Many a quarrel between cow and man might have been averted if consideration had been shown at this point.

Methods of Milking.—A few years ago the Danish or the Heglund manipulation method of milking was quite widely discussed and was tested by the Wisconsin Station. In brief, the result showed that following a slow or weak-handed milker the Danish system of manipulation or massage would materially increase the amount of milk yielded, but when it followed a strong, active milker, little, if any, benefit was derived.

The Heglund system was devised very largely to interest people in general, but farm and village girls in particular, in

taking interest and pride in milking. It served that purpose well, but also demonstrated to all the need of massage of the mammary glands if greatest activity and yield were to be obtained. Ample stimulation seems to be furnished, however, by ordinary rapid, strong-handed milking, followed by a moderate amount of drawing down of the teat and stripping out of the udder. When once the milk flow has been well started, strong-handed, rapid milking is preferable, as such will obtain more milk at each milking and will keep the cow in milk for a longer period of months.

Stripping for some time after the major portion of the milk has been drawn is in part a habit on the part of the cow and the milker. This may be largely avoided if the milker will but draw down firmly on the teat with one hand while gently but firmly squeezing and rubbing downward on the udder with the other. Stripping, as commonly understood, that is, the slipping of the teat between the thumb and finger to finish getting all the milk should not be practiced. The milk can all be drawn with less pain to the cow by finishing with the full hand or with thumb and two fingers.

The first and last milk drawn from a cow differ very materially in fat content. The first is thin, almost watery. The fat in such frequently is only one quarter as great in amount as in the last drawn or the strippings. The amount of difference between first and last depends largely upon how much milk the cow is giving at that particular time. If fresh in milk so that the udder is fully distended, in fact turgid, the first milk drawn may test as low as one-half of one per cent fat, while the stripping test is as high as 9 per cent fat, the last being eighteen times as rich as the first. But with a cow giving only five to ten pounds at a milking, the first may test 2 or 3 per cent and the last 6 or 7 per cent, with an average of 4 per cent for the whole mess. This emphasizes the necessity of milking the cow dry and mixing the milk well before taking a sample for testing, also the fact that if the cow is not milked out clean each time the richest part of the milk is the part lost. Incomplete milking

also is a very common cause of garget as well as causing the cow to dry up ahead of time.

The Milking Machine.—From the many reports by experiment stations, and otherwise, regarding the efficiency and practicability of the mechanical milker it is obvious that at least some of the machines, as now developed, and at present represented by a dozen or more companies, will milk cows, that is, draw from the udder most of the milk contained therein, but that it will not strip out as thoroughly as desired nor yet massage the mammary glands for the purpose of stimulating blood flow, and much less excite in the cow's nervous system the impulse to milk secretion. The fact that some dairymen are continuing to use the machine and are well pleased with it after an experience of from three to six years is evidence that the machine itself is already in a reasonably high stage of perfection, but the fact that many farmer dairymen who introduce the machine later lay it aside, would indicate that the difficulty of finding the right man to operate the machine is great. One is almost tempted to draw the conclusion that the machine has reached a higher stage of perfection than have the operators.

If on a two-man farm forty or fifty cows may be kept by the assistance of the mechanical milker the advantages of the larger number of cows or the small number of men is obvious. In the dairies of fifty or more cows where transient labor must be depended upon, it seems highly probable that one of the mechanical milkers will be found a profitable investment, provided the owner operates the machine himself.

Some machines are not provided with adequate regulators of the suction force, while others have no way provided for the relief of the teat from constant or near-constant suction. Cows do not object to the feel of the teat cups nor to the click of the machine. In fact many now on the market are easier on the cow than are ordinary hand milkers with untrimmed finger nails.

The whole matter of mechanical milkers now resolves itself into three questions, the cost for the number of cows to be handled, the handling so as to keep up the flow of milk and the sanitary character of the product drawn. If a man has feed

and barn room for twenty or thirty cows and can save hiring a man by having a machine, it will pay to put one in, provided he understands machinery reasonably well and understands cows fully as well as would be required if he were to do all the work by hand and will attend to the work in person.

Most or all the machines are now made so that all parts can be cleaned. It is another question whether they will be kept clean. If cared for properly cleaner milk can be produced by machine than by hand, but in practice there is danger that the milk will not be so clean.

The success or the failure of the machine now depends almost wholly on the operator.

The bed of the cow naturally should be comfortable whether made so with shavings or straw. It is the nature of cattle to eat their feed rapidly, then to lie down to ruminate it. If a hard, narrow, or otherwise uncomfortable bed is furnished them, the discomfort will induce activity and needlessly increase the amount of feed necessary for maintenance. Making the cows completely comfortable saves feed (Fig. 59).

Dehorning the cows after maturity gives them less pain than they would inflict upon some sister cow if permitted to wear their useless side arms. Clippers for the removal of horns are not to be advised, since they crush the bone and thereby leave a large number of little slivers which make healing difficult and very slow. A fine meat saw is preferable to any other instrument yet devised. The horn should be sawed so close to the head that a ring of hair about a quarter of an inch wide will still cling to the horn. Cut thus short the horn will not grow, neither will it hurt the animal as keenly as it would if cut a half inch longer, in which case the stub would continue growth and often produce an ugly or annoying malformed horn. It is inadvisable to dehorn in winter because of the cold, and it is dangerous, indeed, to dehorn in summer when flies are bad. If, in the case of an accident, it becomes necessary to saw off an animal's horn during fly season and maggots should develop in the wound, they may be thoroughly expelled by means of turpentine. The wound should then be covered with a wad of cotton saturated

with tar, to form a temporary scab, and to repel flies. It, of course, is preferable to apply the tarred cotton as a precaution rather than as a remedy.

Cows without horns live together so much more peaceably, crowding about the water tank like so many sheep, that the practice of permitting the horns to remain on the working dairy herd should be considered an extravagance, at best a luxury.

As a working practice it is preferable to prevent the horn from growing on the calf by means of caustic.

Sucking cows are liable to develop if calves are permitted to suckle each other after drinking. They often thus learn the

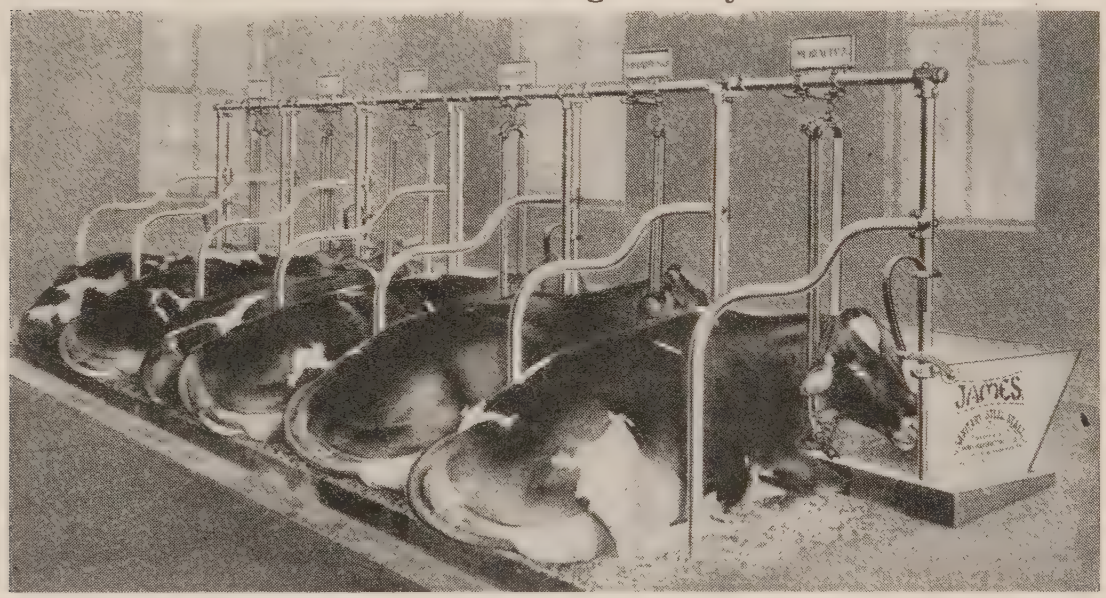

FIG. 59.—Comfort is also economy in the dairy cow stable.

taste of milk from some member of the herd and finally discover that they themselves may be the source of that satisfaction. Various means have been suggested, but the one which most nearly always works is to put into the cow's nose an ordinary bull ring and into this ring a second ring, forming thus a two-linked chain. This so interferes with the process of sucking as to finally discourage it altogether.

It is often a hard habit to break, however, and should be averted by so handling the calves that they do not learn the trick.

Kicking cows are usually developed from rough handling. The more intelligent and sensitive the animal the more likely it is to resent unjust treatment. The heifer with first calf is

nervous and too often unaccustomed to being handled. Quiet self-control on the part of the milker for a few days will usually suffice to convince the young mother that she is among friends with no reason to fight.

In case flies, barb-wire scratch, or other cause has made bad sores upon the cow's teats, greatest comfort in milking is found by first moistening the skin with warm water or milk. A good fly-repelling salve should be used after milking to heal the wounds. In case it is necessary to tie the animal's legs this should be done by tying them together with a soft rope, put on in "figure eight," above the hocks. This will prevent her doing damage and without subjecting her to the strain and excitement which would follow strapping a foot back.

It cannot be too strongly emphasized that the cow is a docile creature, fully willing to be friends with her keeper, and will not kick without cause.

Hard milkers are frequently caused by neglect of the teat in permitting it to become too dry and harsh. This may be overcome by the use of vaseline, which should be thoroughly rubbed into the skin before milking. Slow and weak-handed milking also encourages hard milking. Thus when neglect and weak-handed milking have developed a thoroughly hard milker she may often be brought back into normal condition by the application of oil and strong hands.

Leaking teats are occasionally a great annoyance, since they not only permit the waste of a considerable amount of the milk so preciously formed, but so saturate the floor beneath the animal that the stall becomes sour. This in turn not only produces a bad odor in the barn, but infects the animal as she lies in her place and increases the likelihood of milk being produced which will sour abnormally soon. Occasionally such leaks may be prevented by coating the tip of the teat with a little collodion immediately following milking. Alum rubbed on the moist end of the teat immediately following milking may aid somewhat.

Name the Cows.—Every cow in the barn should be given a name and be called by that name sufficiently often and clearly to enable her to learn it. It gives individuality to the animals

and increases the interest on the part of the attendants. Further, the name often proves valuable in preventing cows from wandering into forbidden parts of the barn, for when they are seen starting, if spoken to clearly, and called by name they realize that they have been discovered and return to their own stall or pass out as desired.

Every cow should be given her own place in the barn, if possible, and taken to that place upon the first visit to the barn. When led directly to the right place and tied and fed she soon learns her place and takes it of her own accord, thus preventing confusion and accidents so liable to result if a barn is opened to a herd, the individuals of which have no definite place.

Watering.—Cows require from three to five gallons, twenty-five to forty pounds of water, per day when dry and from three to four times that amount when milking. In calculating tank capacity 160 pounds or twenty gallons will be required each day for each cow. If the cow is compelled to drink ice water in winter the feeder may calculate that the heat in two pounds of hay will be required simply to warm the water from the temperature of the pond or icy tank to that of the animal's body and that half or more of this loss can be saved by tempering the drinking water to about 70 or 80 degrees. This is particularly desirable when cows are watered from a large tank out of doors. The violent shivering so often seen in cows and horses just after drinking a lot of cold water is nature's way of giving the animal exercise to warm the water. (See paragraph on Stable Temperature.) While some cows will drink only once a day by preference, most desire to drink at least twice. A cow milked very heavily should be watered at least four times a day or, better, have water available at all times, either in a pail or drinking fountain.

Methods of Watering in Barn.—A private drinking fountain for each cow is not essential to economical milk production, nor even to high production. They are expensive to install and necessitate labor in keeping them clean. Further than this, it will be found good practice, even in cold weather, to turn the cows out once or twice a day to give them a chance to limber

up by a little walk and opportunity to discover one another. Unless use is made of this fact the intense dairy cows are liable to go over period after period of heat unnoticed. During winter the cows should be watered in the yard on warm days and from a tank at a convenient place in the stable during severe weather.

It, however, is exceedingly convenient to have a watering device in the stable whereby the cows may be watered while still in their stalls (Fig. 60). A convenient method of doing this is to run a water pipe along the top of the cement base of the manger in front of the cows, then to have holes drilled at intervals to allow the escape of water into the concrete manger. Thus all cows receive water at the same moment. This prevents reaching and slipping, also saves water.

Another convenient method, where the manger will not permit its use as a trough, is to extend the water pipe in front of the cows with a faucet and short hose between each two cows. A pail may then be set into the manger and water drawn directly into it from the pipe close by. This requires a little more time but is cheap of installation, and will not be needed except during severe weather when field work is usually not pressing.

Salt Requirement.—Not only from nature in general, but by exact experiments, it is known that cows require salt in order to remain in health. In a test a few of the cows broke down after less than a month of salt fasting, whereas others withstood the strain for more than a year, but these finally and suddenly developed a thoroughly miserable condition, which, however, was quickly alleviated by the addition of salt to the ration. Heavy milkers need more salt than those that give but little milk. Salt not only whets the appetite of the cow, but seems also to lessen the waste from the body of protein of feed or muscle, or in other words, a little salt regularly fed or placed where the cow may eat it at will tends to save other feedstuffs. The fact that the addition of salt to hay or grain mixture makes the feed more palatable is an important item, since feed that is well liked is more easily and thoroughly digested. Cows need about one ounce of salt per day on the average. Salt bricks attached to the side of the stall are of no particular advantage. Common barrel

salt costs much less and is more easily given and also permits being mixed with the grain or the admixture of bone meal, which is a special advantage to young stock.

Change of routine in doing the work of the stable should be avoided so far as possible. It is preferable that the feed for the day be divided into two equal parts and fed, half in the morning and half in the evening. The grain should be fed first and while it is being consumed the milking should be done. This aids in getting the cow into an agreeable frame of mind and lessens the likelihood of a quarrel with the milker and makes for

FIG. 60.—The drinking fountain, convenient but not essential. (Photo loaned by James Mfg. Co.)

larger flow of milk. Hay should be fed after milking because it will fill the air of the stable with dust, which dust carries immense quantities of mould, and bacteria, which will hasten the spoiling of the milk if permitted to enter it. Silage should be fed after milking because of its odor. Cows should be watered twice a day, once in the morning after eating their feed and again in the afternoon just before being fed.

Punctuality and regularity are very positive virtues in dairy workers, for not only does the work itself depend on it, but the amount of milk the cows will yield as well. Even with proper

feed and comfort, if regularity is lacking, a cow will not yield what she otherwise would.

A dog on a dairy farm may or may not be a nuisance; that depends upon his character and training. The ordinary sort, however, is an expensive luxury which is not to be recommended. A good Shepherd or Collie, however, may very readily be trained not only to save many steps, but also to do general police duty on a livestock farm and thereby be of real value.

QUESTIONS

1. What is the normal gestation period for cows?
2. What time of the year is generally the best time for cows to freshen? Why?
3. How may a spring cow be put on to a fall-calving schedule?
4. How much rest does a cow need between lactation periods?
5. Tell how to dry off a cow.
6. How should the dry cow be fed?
7. What is meant by "conditioning" a cow?
8. How may the manure serve as an index in feeding?
9. When should cows be milked before calving?
10. What care should be given at calving time?
11. How should the cow be cared for after calving?
12. How many times a day should a cow be milked when fresh?
13. At what time does a cow give most milk?
14. How soon after calving ought a cow to be bred?
15. What percentage of a mature cow's record is the first year of work? Second year? Third year?
16. How may the feed affect the test of milk?
17. What effect has a drought on the quality of milk?
18. What effect does turning cows out to pasture in the spring have upon the quality of milk yielded?
19. Which is preferable, a large or a small pasture for cows?
20. How many acres are required to pasture a cow?
21. How is midsummer short pasture to be met?
22. How should milking be done?
23. What is the value of the Heglund method of milking?
24. How do the first and the last milk drawn from a cow differ?
25. What of the milking machine? Have you seen one work?
26. What temperature is best suited to dairy cows?
27. Discuss light in the dairy barn.
28. What is the best way to dehorn?
29. How may hard milking be made easier?

CHAPTER XX

HOW CAN I GET THE MOST FROM THE COWS I HAVE?

THE immediate problem which confronts many, probably most, American farmers to-day is not so much what breed or strain of cows would be most profitable to keep if they could have what they want, but rather how to get the greatest returns from what they now have. All realize that a few cows are outstandingly valuable and that there is a small horde of lesser power that are very good, but the number of high-producing cows is altogether too small to furnish each farmer with a herd or even with one specimen, and that for some time the bulk of the dairy work of this country must of necessity be done by grades only moderately well suited to their tasks.

Common cows have repeatedly shown themselves capable of producing much more and more economically than is generally realized, even 50 to 100 pounds of fat per year. To secure such results, however, the " common " cow must be accorded " pure bred " care, *i.e.,* she must be fed and treated right. In general, farmers should keep the cattle they now have, and build up. The following are the chief points in getting what we can out of the cows we now have:

1. Fall fresh to produce more milk. See Chapter XIX.
2. Comfortably housed to save feed. See Chapter XXI.
3. Succulent feed, silage, to encourage liberal eating. See Chapter XXIII.
4. Feeding liberally so cow can have something to work on. See Chapter XXIII.
5. Fair amount of grain so cows may be able to consume more nutriment. See Chapter XXIII.
6. Balance of nutrients, so the body and the milk may be adequately fed. See Chapter XXIII.
7. Treated with kindness so she will be willing and glad to let down the milk. See Chapter XIX.

8. Regularly fed and milked so the cow's system may not be frequently thrown out of tune. See Chapter XIX.

9. Liberally watered, twice daily. See Chapter XIX.

10. Protected from heat and flies in summer. See Chapter XIX.

11. Milked quickly and thoroughly. See Chapter XIX.

12. Dehorned. See Chapter XIX.

13. Milk weighed and tested. See Chapter XVIII.

14. Best cows kept and bred to pure-bred bull.

Our grade cows must of necessity serve as foundation, but we should aim to build higher than the foundation only. Life is too short to spend on inefficient cows any longer than necessary.

QUESTIONS

1. How should a man proceed to secure a profitable dairy herd when he has no cows to start with?
2. When he has a herd of untested grades on hand?
3. What three things should guide him in selecting a breed?
4. What points should be looked out for in selecting a bull?
5. What "off color" in Guernsey and in Holstein bulls may sometimes be taken advantage of?
6. What must a pedigree show in order to be a good one?
7. What are the advantages of community breeding?
8. How are community breeding associations operated?
9. How are daily milk records valuable?
10. Show how the three-day record is worked.
11. What is the plan of operation of coöperative dairy test associations?
12. What results have been attained by organized cow testing?

CHAPTER XXI

SOME FEATURES OF THE DAIRY BARN

The stable need not be expensive but should be made to furnish as nearly as possible the condition which naturally surrounds the cows during that time of year in which they universally produce milk most abundantly, namely, the spring or early summer. The cow does not care for the time of year, but rather for conditions (Fig. 61).

Certain features of the dairy barn and cow stable are very often under discussion, chief among which are such matters as the preferable kind of floor, whether cows should be faced outward or inward, and the like.

Hay storage over a cow stable is thoroughly permissible even in well organized cow barns, provided simply that there be a good tight floor between the hay and the cows. The breath of stock injures, or even ruins, hay or fodder if stored above without being protected. It is economy to provide the hay floor. Also the dust that gathers on hay or straw over stock will so easily and so often be knocked off into the air of the stable that clean milk could only with difficulty be produced under such conditions.

The floor material best adapted for use in dairy cow stables is concrete. This may well be left exposed in walks, alleys, gutters and mangers, and may be a foundation under the cows, but should be overlaid with some non-conductor of moisture and heat where the cows must stand and lie. Common soft-wood plank soaked in tar or creosote will render much good service, but has the disadvantage of wearing out too quickly and also of offering many cracks which, if not filled with tar, will collect dirt. Cork bricks are made of bits of cork compressed into the form of common bricks, being held together by asphaltum or similar material. Such brick are good as covering for a strong, coarse concrete foundation, especially in being warm, not severely hard on the cow's feet, and waterproof (Fig. 62).

The cost of cork brick is about $48 to $50 per 1000 and

50 to 60 bricks will be required per cow. Of consequence too is the fact that they are not made uniform in thickness, so that a smooth floor top is difficult to make.

Creosote wooden blocks, such as are now so much employed in surfacing city streets, are now being much used for cow-stable floors. They are cheap, very durable, sanitary and warm. Of these blocks, about ninety will be needed per cow.

An insulating layer in the concrete makes the floor dry and warm. The time to install the insulating layer is when the

Fig. 61.—A typical Vermont barn. Note team approach on three levels. (Photo by author.)

floor is being constructed. After the rough grouting is poured a layer of tar paper is nailed on it all over the cow beds. The nail heads are left projecting half an inch so that when the finish coat is poured the nails will help to hold it in place. Two coats of coal-tar paint is sometimes used instead of the tar paper. Either will prevent the capillary action of moisture through the cement and the floor will be warm and dry. The top layer of cement will retain the heat of animals much as soapstone does.

Facing cows inward makes feeding easier and the cleaning is as easy if a litter carrier be provided. But the plan has the distinct disadvantage in that the walls are certain in a very few

days to become fouled by the spattering manure unless a wide walk is left behind the cows, or a deep manure gutter is provided. Any manure on the walls must remain to be unsightly and a reproach to the manager or be scrubbed off. It should be remembered too that fresh manure contains a slimy substance from walls of the cow's intestines which renders it sticky. On the early-day log stables fresh cow manure was regularly used as a mortar to plaster up the cracks between logs and chinks where it would withstand weathering for several months. On the wall behind the cow it will remain until scrubbed off. Such work is expensive in time and wholly non-productive.

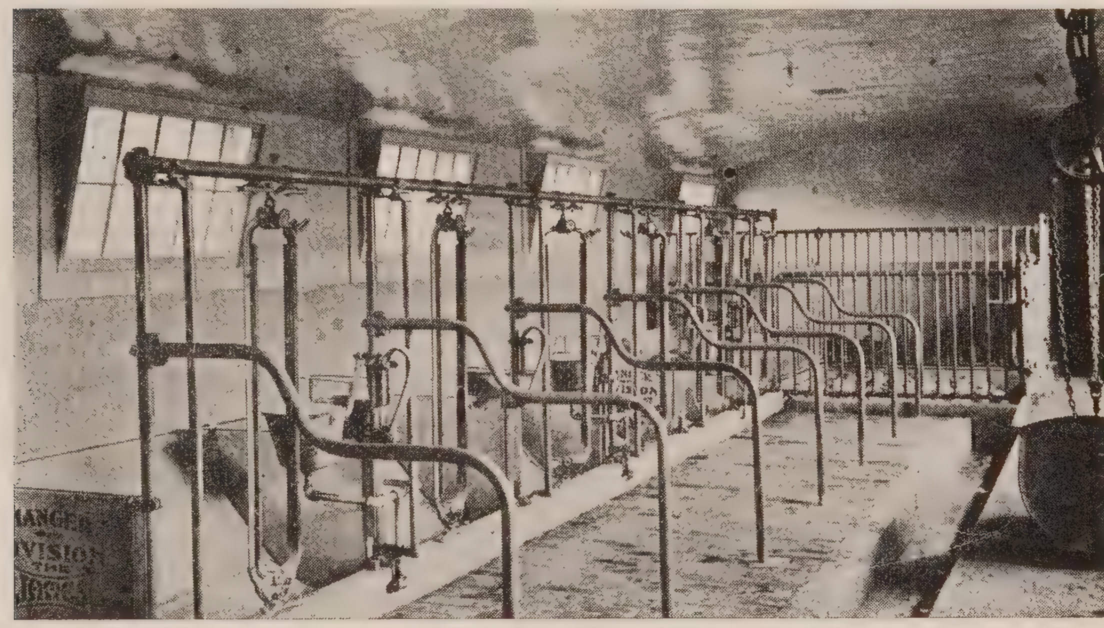

Fig. 62.—A substantially built cow stable. Note the deep cement gutter and the cork brick floor where the cows are to stand.

Many good dairymen provide deep gutters for the manure and wide walks behind the cows, and then prefer to have the cows face inward. They then have their eyes away from the bright light of windows.

By facing the cows outward the walls are kept clean and the floor between the two rows of cows may be cleaned far more easily than the walls. Furthermore, the difference in the standard of cleanliness for the walls and the floor renders it many times more easy to keep a cow stable presentable when the cows face outward rather than inward. If cows face outward

it is very often true economy to make the stable wide enough to permit a wagon or even a three-horse manure spreader to be driven through the barn from end to end, in order that the manure may be removed with the least possible amount of labor and drawn directly to the fields (Fig. 63).

Arranged so, the cows have a wide door through which to enter the stable, thus lessening the danger of accidents due to crowding. It also gives the cows more room to enter and leave their stalls in comfort and safety.

In sale stables too it is desirable to have all the animals in sight from one point. They show up to better advantage. All things considered, there are many who prefer the out-facing system. Each plan has its own advantages, and both plans will continue to be followed by good dairymen.

Ventilation of the Stable.—In a sense, air or the oxygen contained in it, is a food, since the carbon contained in the feed eaten cannot undergo oxidation and liberate heat and energy without it. Furthermore, body tissues are constantly wearing out and, in the form of carbon dioxide, are being thrown off largely in the exhaled air. Much moisture and some organic particles also escape from the body in the warm breath and in addition to these exhaled impurities, various gases, such as ammonia and marsh gas, are passed which aid in defiling the air. Molds and bacteria grow abundantly in straw and hay in an atmosphere so moist and full of organic matter.

Diseases of all sorts are more liable to be spread and contracted, and to be intense in their action in a badly ventilated stable. Even if specific diseases are not present, however, a bad atmosphere is undesirable because it is depressing in every respect on both the stock and the laborers who must spend a portion of their time in it.

The amount of air breathed by an average cow is given by King[1] as about 2800 cubic feet in 24 hours or about 224 pounds, —about twice the weight of feed and water required. This is not to say that all oxygen in such a volume of air was used.

It is generally calculated that the stable should be sufficiently

[1] King, F. H. Physics of Agriculture, Second Edition, p. 354.

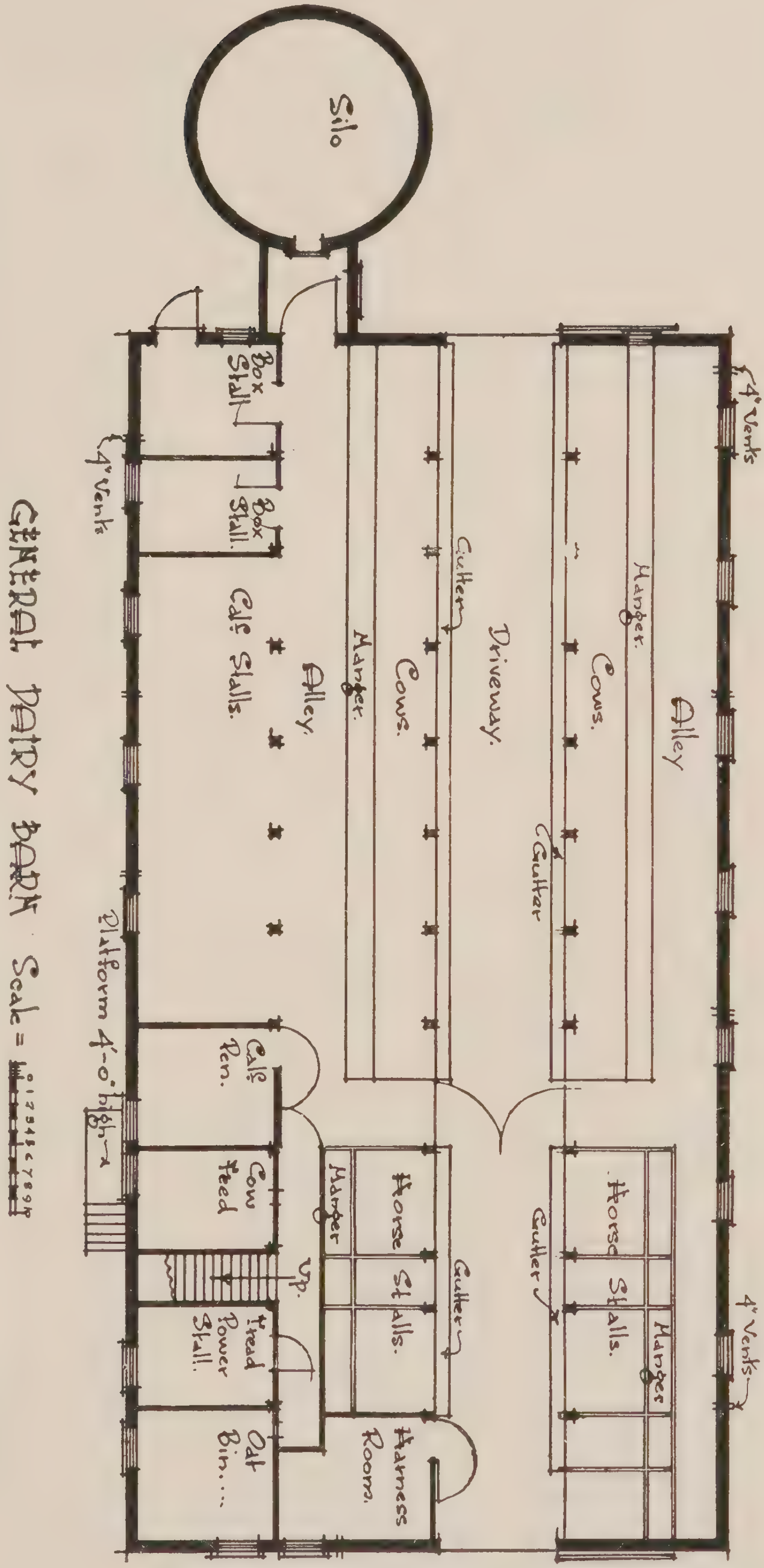

FIG. 63.—Plan of general farm and dairying barn on Woodland Dairy Farm, Monticello, Minn. Note broad driveway and out-facing of stock.

commodious to permit 600 cubic feet of air space per cow. This, as a necessity, however, must depend upon the rate of exchange of the air. There should be some inflow and outflow of air even in the largest stables. Too much circulation in winter is obviously detrimental. In this aggravating matter the southern dairyman, with his lattice-sided barns, has a decided advantage.

The forces that produce ventilation in stables are (*a*) a wind pressure against the side of the building tending to force air in; and a suction on the opposite side which tends to draw it out; (*b*) the air friction over the top of the ventilator flue causing a draft as in tall chimneys and (*c*) the difference in the temperature between the air of the stable and that of the outside. The relative values of these three forces will naturally vary continually with conditions (Fig. 64).

A Choice of Systems.—Poorly constructed stables will need no system of ventilation. Many northern barns need battening rather than more airing.

During much of the year, even of winter in the northern states, windows may safely be opened to hasten air circulation, especially if the windows be hinged at the bottom and set to slant inward when open (Fig. 65).

On many occasions, when the wind is blowing strongly, a curtain of common cotton cheesecloth or muslin, or burlap sacking, may be tacked over the window. This is best done by first tacking the muslin onto a frame and slipping the frame into place when needed in cold weather. There are times and conditions, however, when a more systematic ventilation is desirable. For such there is probably none better than the well known King system, developed by Prof. F. H. King, of Wisconsin University.

The essential features of the King system are: (1) An outgoing air duct and (2) an opportunity for air to enter to take the place of that drawn out. The out-going ventilator shaft should be comparatively large and smooth to reduce friction within, as straight as consistent with the plan of the barn and extending up through the roof, not terminating in the hay loft but open into the cupola. The air duct should be of wood or if of

tin or galvanized iron, be covered over with boards. This insulation is to prevent the cold air of the hay loft from so cooling the out-going air as to check it, and turn it downward. The air inlets should be smaller and of greater number than the outlets. They consist of shorter shafts through which the air must rise before entering the barn.

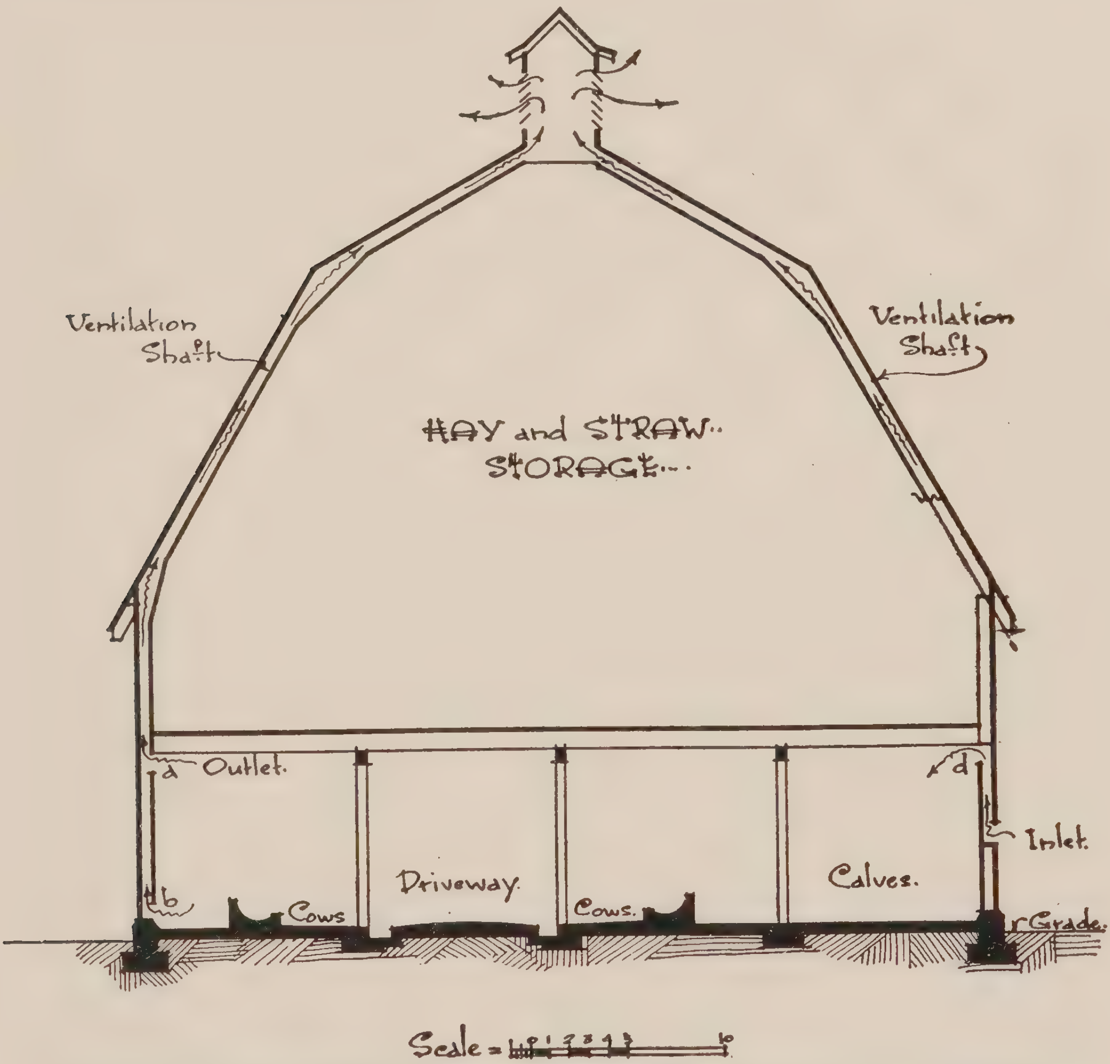

FIG. 64.—Elevation Woodland Dairy Farm barn. Note system of ventilation. a, outlet in summer; b, outlet in winter; and d, inlet at all times. Also the dirt-tight floor over the stock. Straw for bedding as well as hay for feed is stored in the loft.

The location of the flue would best be near the center of the stable. This permits a straight duct and encourages draught but may be against the walls and roof. In summer the warm air at the top of the stable may be drawn away, while in winter the suction may commence at the floor as shown in figure 64. The air inlets should be made in the walls so as to admit the fresh

air near the top of the stable, just below the hay floor, or, if no hay is stored overhead, about seven feet from the floor.

Much trouble has been experienced with the system if not properly installed. The author hesitates to recommend it or any other system to those who do not understand its principles. In practice, a thoughtful use of windows and muslin curtains will go a long way toward solving the problem.

The muslin curtain at the window furnishes an economical and fairly efficient means of drying the atmosphere of the stable and permits thorough mixing of fresh air with the old. If the muslin is fastened to a frame that may be slid into place it may often be used when the temperature or the wind would not permit windows to be opened with safety. On mild days, of which all parts of the United States have so many, the doors or top half of the doors and windows may be opened with safety and good results. Under some circumstances the muslin curtain is to be recommended over any other system.

The temperature of the stable should, so far as possible, not be permitted to go lower than about 45 and not much higher than about 70 degrees. A temperature of about 60 degrees seems to be the one best suited to dairy cows. A high temperature, 85 degrees or above, causes the cow to lose her appetite, and go "off feed" easily if being at all crowded. A cold temperature in the stable, on the other hand, cools the cow's body just as it would any other warm object and requires that the cow make it up by eating more feed. The temperature must be maintained if life is to continue. Nature's safety valve in this matter is tense muscles and shivering. Literally, therefore, a cold cow must shiver herself warm, as queer as this may sound. We all know how tired we feel in the morning after having "slept cold." We were tired because our muscles had been at work, drawn tense, to keep us warmer.

Good light is necessary in the stable for ease in doing the work and for keeping it clean, as well as being desirable from the standpoint of the cow herself. Too much light, however, is wearying to any animal and thus expensive. The most serious objection to facing cows outward is that they will face more or

less directly against the windows. But if these are only moderate in number and placed horizontally so that the bottom is about four and one-half feet from the floor, the light will not be severe on any and will be actually restful to all those located between the windows.

To make it lighter for work throughout the stable the whole interior may be whitewashed. In fact a good whitewashing applied by means of a spray pump to reach the crevices and cracks is to be recommended once or twice a year to kill disease and other germs. Many barns have been built, of late years, with so much glass surface as to be too warm on bright days and too cold on windy ones and at the same time not particularly well lighted because the interior was left in some dark color. A more wholesome and dependable condition can be procured by employing less glass and more whitewash.

The dimensions of the stalls best suited to dairy cows naturally vary with the breed or rather the size of the cows to be fitted. The following table will indicate the needed distances:

Name of Breed.	Box Stall.	Width of Single Stall.	Distance from Manger to Gutter.	Thickness of Neck.
	Feet			*Inches*
Shorthorn	10 x 12	3 ft. 6 in.	4 ft. 4 in. to 5 ft. 2 in.	5 to 7
Holstein-Friesian	10 x 12	3 ft. 6 in.	4 ft. 6 in. to 5 ft. 3 in.	5 to 6
Brown Swiss	10 x 12	3 ft. 10 in.	4 ft. 8 in. to 5 ft. 4 in.	6 to 8
Ayrshire	9 x 10	3 ft. 3 in.	4 ft. 4 in. to 5 ft. 0 in.	4 to 5
Guernsey	9 x 10	3 ft. 3 in.	3 ft. 10 in. to 4 ft. 8 in.	4 to 5
Jersey	9 x 10	3 ft. 3 in.	3 ft. 10 in. to 4 ft. 6 in.	4 to 5
Calves		2 ft. 3 in.		3 to 4

Naturally, the breed of cows to be kept should be settled upon before the stable is built.

It is found very convenient to have the width of the bed on which the cows stand vary from, say 5 feet 3 inches at one end to 4 feet 3 inches at the other, if Holsteins are kept, or from 4 feet 6 inches to 3 feet 10 inches for Jerseys. In this way smaller cows of the breed or young stock may be placed at one end of the barn and larger ones at the other end, where they all will be kept clean.

As to the width needed, many people try to save space and in doing so cramp the cows and surely cause them to be uncom-

fortable. An increase in width of a Holstein cow's stall from 3 feet 4 inches to 3 feet 6 inches is as nothing compared with the commodious apartments generally provided beef cattle. Bodily comfort is true economy with dairy cows.

The manger may very profitably be made of concrete, but care should be taken to build up the bottom to at least one and better two inches higher level than the cow's feet. It should also be made to slant toward the cow in order that she may reach her feed without straining or slipping (Fig. 65).

Fig. 65.—Note broad feed alley and slant of windows.

QUESTIONS

1. Under what conditions may hay very properly be stored over cows?
2. What material is best adapted for use as stable floors?
3. What material should be used on the floor where the cows stand?
4. Tell the advantages of facing the cows inward in the stable.
5. What are the advantages or disadvantages of facing the cows outward?
6. How may a stable most economically be lighted?
7. What other advantages are to be gained by thorough whitewashing?
8. Give the dimensions of stall best suited to the cows of various breeds.
9. Explain the forces that cause a circulation of air in the King system of ventilation.
10. Explain the use of the muslin curtain.

CHAPTER XXII

COMMON AILMENTS OF CATTLE*

WHILE it is not intended that this volume shall be a book on veterinary practice, it is well known that the regular herdsman or caretaker should be able quickly to recognize when his charges are out of health and be able to treat the commoner or simpler afflictions. These considered here are those most frequently to be dealt with.

TUBERCULOSIS

Tuberculosis is a widespread infectious disease caused by the bacteria of tuberculosis affecting man and lower animals.

Occurrence.—Tuberculosis exists in all civilized countries. In America the disease was introduced with early importations of cattle and has gradually spread until no section of the country is free from it. The exact percentage of tuberculous animals in any country is unknown, but the relative number has been determined by tuberculin testing and by post-mortem examinations in abattoirs. The Secretary of Agriculture, in his report for 1908, estimated that one per cent of beef cattle and ten per cent of dairy cattle were tuberculous.

Importance.—Tuberculosis is to-day the most serious problem confronting the livestock industry. The disease is probably not on the increase among cattle, but is becoming more prevalent among swine and poultry. Thousands of infants and young children receive cow's milk as their chief diet and it is usually consumed in the raw state. Milk from cows affected with tuberculosis often contains living virulent bacilli of tuberculosis. Children consuming this milk may develop tuberculosis, which is frequent cause of death. Scientific investigations show that a certain percentage of human tuberculosis is of bovine origin, the germs being transferred through the use of milk, butter, and cheese, or improperly cooked meat of animals.

Nature of Tuberculosis.—Tuberculosis is, as a rule, a chronic, insidious disease which spreads slowly from animal to animal in a herd until most of them are affected. Tuberculosis

* Written by Dr. W. L. Boyd.

develops very slowly and for this reason many owners of cattle do not suspect its presence in their herd until several animals have become diseased. If tuberculosis were rapid in its development and caused death within a few days like some of the other infectious diseases of cattle, rigid measures would soon be adopted in order to check its progress and dissemination. In many parts of our country it is customary to allow hogs to feed in the dung of cattle. If the cattle be tuberculous, their manure will quite often be laden with virulent germs which, when taken up by the swine, cause them to become diseased. Especially is this so in herds where the disease has become extensive. Tuberculosis is not hereditary, but the offspring of tuberculous parents acquire a predisposition to the disease; *i.e.,* they are more apt to become affected with tuberculosis when exposed to the infection than are the young born from healthy parents.

Symptoms.—The symptoms or signs of tuberculosis are numerous and while some of them are quite suggestive of tuberculosis, not one can be relied upon with any great degree of certainty in the establishment of a diagnosis. In some infectious diseases, certain symptoms occur which are characteristic of that disease alone. Characteristic symptoms or signs are not observed, however, in tuberculosis. Tuberculosis may be present in fat, sleek-looking cattle which show no symptoms of ill health (Fig. 66). Such cases can be detected by the tuberculin test only. The symptoms of tuberculosis vary according to the organ affected. In some instances unthriftiness and loss of flesh will be the chief symptoms observed (Fig. 67). When the lungs are diseased a rather weak, subdued, infrequent cough will be noticed. This cough is most severe in the early morning or after exercise, and after drinking, respiration becomes more difficult and at times quite rapid. The appetite gradually decreases and intestinal derangement develops. When the intestines are diseased diarrhœa is a prominent symptom. Enlargement of the superficial lymph glands in the region of the throat and neck are of frequent occurrence. When the glands of the chest become enlarged, sufficient pressure is at times exerted on the gullet or œsophagus to cause the animal to suffer

Fig. 66.

Fig. 67.

Fig. 66.—Cow in good condition and apparently healthy, yet tuberculous. (Courtesy of M. H. Reynolds.)

Fig. 67.—Bull thin and unthrifty, due to the effects of tuberculosis. (Courtesy of M. H. Reynolds.)

from bloat. Bloating, however, is not a frequent symptom. The body temperature may be normal, although we more frequently find it to be irregular, being inclined to be much higher in the evenings. Tuberculosis of the udder manifests itself by the formation of hard lumps or swellings in certain parts of the gland. Milk from such an udder should not be used, as it is quite apt to be laden with germs.

The Manner by Which the Disease Spreads.—Tuberculous cows sooner or later give off the germs which may escape, by the mouth, the nose, in the milk, in the manure, and in the discharges from the genito-urinary organs. When the germs are thrown off in any of the above-named ways, the disease is known as open tuberculosis. The germs discharged from the mouth and nose are coughed up from the lungs, some of which are swallowed while others are sprayed over the feed in front of the cow. Cows in adjoining stalls may take in these germs with the feed or the water and thus contract the disease.

The manure and urine from tuberculous animals usually contain the germs and will spread the disease unless properly disposed of. Manure mixed with the germs of tuberculosis may fall into the milk pail or be carried to the milk direct by the cow's tail and thus contaminate the milk. The germs are not removed when the milk is strained. When the disease affects the udder the milk, as a rule, contains the germs in vast numbers. Such milk will readily transmit the disease to young animals. Milk of this kind is also very dangerous to young children.

The Manner by Which a Herd Becomes Infected.—The principal ways through which tuberculosis may be introduced into a herd are: First, through the buying of cattle from other herds infected with the disease. Buyers should purchase only from healthy herds in order to safeguard their healthy animals. Second, calves may become infected by feeding them milk, buttermilk, or whey from tuberculous cows. Such material should not be fed unless boiled or pasteurized. Third, by allowing healthy stock to mingle with diseased animals. Fourth, by keeping cattle in poorly ventilated, insanitary, dark, and unclean quarters.

Tuberculin Test.—Only a small percentage of tuberculous

animals can be detected by a physical examination. In many cases only a few symptoms can be determined, and these are not characteristic, as they may also occur in other diseases. The tuberculin test is very accurate and when skillfully employed detects the diseased animals practically without fail.

What Is Tuberculin?—Tuberculin is a fluid containing the products (toxins) of the tubercle germ without the germs themselves, therefore when tuberculin is injected into healthy cattle, it cannot cause tuberculosis. Tuberculin injected into tuberculous animals causes a marked temperature disturbance. The tuberculin test may be applied by three different methods: (1) The subcutaneous or temperature test; (2) the ophthalmic test, and (3) the intradermal test.

The subcutaneous test is the oldest method and the one most commonly used, although the ophthalmic and the intradermal tests are thought to be just as accurate.

Tuberculin, when injected into diseased cattle, causes them to become feverish within eight to sixteen hours after the tuberculin is administered. The fever lasts a short time and then subsides. This temporary fever is called "the reaction," and the animals so affected are called "reactors."

In the subcutaneous test, the tuberculin is injected under the skin, preferably in the region of the neck. Two or three temperatures are taken, two or three hours apart, before the tuberculin is injected in order to ascertain the animal's normal temperature. Eight or nine hours following the administration of the tuberculin, the temperatures are again taken every two hours until six temperatures have been recorded. The animals which are found to be feverish are regarded as being tuberculous.

The ophthalmic test consists in inserting a drop of tuberculin into the eye of the suspected animal. If the animal is healthy, no change takes place, but if affected with tuberculosis, the eye becomes reddened and waters profusely.

The intradermal test consists in injecting a very small amount of tuberculin into (not under) the thin folds of the skin at the base of the tail. A reaction consists of the appearance of a swelling about the size of a walnut at the site of injection,

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which remains for seventy-two hours or longer and disappears very slowly.

Limitations of the Test.—The tuberculin test should not be applied to cows that have just calved, as the temperature at this time is apt to vary considerably from the normal. Calves under six months of age should not be tested, as their temperature is quite changeable. Cattle in the advanced stages of tuberculosis sometimes fail to react to the test, but such cases can usually be detected by a physical examination. Cattle that have just recently become infected may fail also to react. The tuberculin test, when employed by thoroughly competent men, is by far the most accurate method available for detecting tuberculosis. The records of large numbers of tests made by government officials show that the tuberculin test is accurate in ninety to ninety-five per cent of animals tested (Fig. 68).

INFECTIOUS ABORTION OF CATTLE

Infectious abortion is a specific infectious disease produced by the germ, *Bacillus abortus,* and characterized by inflammation of the mucous lining of the uterus (womb) and fœtal membranes resulting, as a rule, in the expulsion of the fœtus (calf) in an immature condition. Infectious abortion is known also as contagious abortion, epizoötic abortion, enzoötic abortion, and "slinking" of calves.

Cause.—The bacillus of abortion, which was described in 1897 by Prof. Bang of Denmark, is a short nonmotile rod possessing peculiar physical requirements which make it rather difficult to cultivate artificially. In the diseased cow the organism lives in the mucous lining of the uterus (womb) and it is at times found in the milk of affected cows. Abortion bacilli inhabit the intestinal canal of the affected fœtus. Outside of the animal body little is known of the organism.

The *Bacillus abortus* is capable of producing abortion experimentally in cattle, mares, sheep, goats and swine, by feeding and by injecting the organisms into the circulation.

Susceptibility.—Infectious abortion is chiefly a disease of heifers, yet in given herds there will be certain periods in which all of the cows will abort regardless of age. Infectious abortion does not confine its ravages entirely to dairy breeds, but attacks

other breeds of cattle with little less severity. Many heifers will abort once and then carry their second calf for the full period. A less number will abort their second calf and it is a rare condition when a cow aborts the third time. Heifers from aborting mothers may be less susceptible than those born to healthy or noninfected dams.

The Manner by Which Abortion Becomes Disseminated.—The mucous lining of the uterus of infected heifers and cows harbors the *Bacillus abortus.* The contents of the uterus, such

FIG. 68.—Heifer, thin and in poor condition, though not affected with tuberculosis. (Courtesy of M. H. Reynolds.)

as the fœtus, fœtal membranes, and the fluids, are all virulent and when expelled from the uterus become vehicles by which the disease spreads. The discharge from the uterus following abortion contains myriads of bacilli (germs) which may be carried to various parts of the stable by aid of the surface drainage; attendants may carry the infection on their boots or on the milking utensils which are at times carelessly handled. The bull is undoubtedly a frequent carrier of the infection, especially where several breeders use the same animal. Infected pregnant heifers or cows introduced into healthy herds are often responsible for establishing new centers of the disease when they abort.

This is probably the chief way by which the disease disseminates, as it is imposible to tell by a physical examination whether a cow is diseased or not. Milk from aborting cows may be a carrier of the infection.

Natural Mode of Infection.—The route by which the germ gains entrance to the animal body is a debatable question. Some authors hold that the open cervical canal at the time of œstrum is the chief avenue of infection, being introduced into the cervix and uterus at the time of copulation (breeding). No doubt the bull is responsible for the transmission of the disease in a great many cases, especially is this true in herds where only one bull is used, he being allowed to serve both diseased and healthy cows. In abortion occurring among range cattle, the bull is probably responsible for carrying the infection from one cow to another, principally at the time of breeding. The digestive tube undoubtedly acts as one of the chief channels of entrance, the infection being obtained from contaminated feedstuffs, including pastures where diseased animals are allowed to graze. Artificially the disease has been produced by injecting virulent abortion bacilli into the veins and under the skin. It has been produced by feeding infected material. Abortion has also been produced by placing virulent material in the vagina of pregnant cows.

Symptoms.—The period of incubation in infectious abortion varies widely. In producing the disease experimentally certain workers have determined the average period of incubation to be approximately 130 days. The premonitory symptoms when noticed consist of doughy swellings of the udder, and vulva, followed by a mucus-like odorless discharge from the vagina. The discharge may at times be streaked with blood, relaxation of the sacro-sciatic ligaments, restlessness and stamping of the hind feet. These symptoms usually appear one or two days before the abortion occurs. Occasionally heifers have been observed to make bag and even lactate at the fifth month of gestation, the abortion not taking place until the seventh month or in its membranes, but when the abortion occurs after the fifth and sixth months of gestation it is not always indicative of abortion. Cows will be observed to abort suddenly without manifesting premonitory symptoms. When heifers or cows abort in

the early stages of pregnancy the fœtus will be expelled enclosed in its membranes, but when the abortion occurs after the fifth month of gestation the membranes (afterbirth) are usually retained. The large percentage of abortions take place between the fifth and seventh months of pregnancy, although abortion may occur any time during the period of gestation. Great excitement may be noticed in heifers following an abortion and at times will show all the signs of the heat period. The discharge from the uterus and vagina, following abortion, continues for two or more weeks, and may continue longer when the inflammation of the lining of the uterus becomes severe. The discharge is of a dirty, yellowish gray color, tenacious in character, and accumulates on the tail and other parts to which it may come in contact. The appetite is impaired but gradually improves as they recover from the effects of the abortion. The milk flow is slight but increases gradually as the animal recovers. The fœtus is, as a rule, born dead or if alive is weak and undersized and dies within a few days with symptoms of diarrhœa or remains in a stunted condition. Cases in which the fœtus has become mummified occur in infectious abortion. Such cases are, however, rare. In a number of cases, cows that have apparently recovered from the effects of the disease fail to conceive though served by the bull numerous times before becoming impregnated, or may never again get with calf (non-breeders).

Sterility in the greatest percentage of cases is probably due to pyometra (pus in the uterus), the result of retained placenta or afterbirth. In other cases the ovaries undergo cystic degeneration, which, if extensive, often causes the cow to be constantly bulling. Cases of this type are, as a rule, non-breeders. Sterility is one of the chief characteristics of infectious abortion.

Diagnosis.—In a herd where several calves have been aborted in an immature condition, and especially if the aborting animals be heifers, one is usually justified in regarding the condition as infectious. The history, of course, should be taken into consideration. Where infectious abortion cannot be diagnosed clinically, the following methods of diagnosis have been recommended: (1) Bacteriologic. (2) Serologic.

Bacteriologic Diagnosis.—Microscopically best results may be obtained by examining smears prepared from the stomach and intestines of the fœtus soon after abortion. If small cocco-bacilli are present in large numbers, one is quite safe in considering them as abortion bacilli. Cultures made from the stomach of the fœtus give, in a large percentage of positive cases, cultures of *Bacillus abortus.*

Serologic Diagnosis.—The success of serum diagnosis in other diseases induced the various workers in veterinary pathology and bacteriology to apply the complement-fixation and agglutination tests to infectious abortion. The serum method of diagnosis is quite accurate in determining the presence of infectious abortion. All heifers or cows affected with abortion form certain substances in their blood known as anti-bodies. By the aid of the complement-fixation or agglutination tests the greater percentage of these cases can be determined. Some cows may give positive reactions to the serum tests, yet not abort. The indication, however, is that they are or have been infected with the *Bacillus abortus.* Positive reactions in herds where infectious abortion is unknown are rare. By the aid of the serum tests one can determine the extent of the disease in a herd.

Prevention and Treatment.—As no drugs or medicinal agents have thus far been discovered for the cure of this disease the treatment necessarily becomes preventive. In herds where abortion has recently appeared it is advisable to practice isolation of the aborting cows, not allowing them to come in contact with healthy cattle until all signs of disease have disappeared. In cases of retained afterbirth, the same should be removed by the hand within 24 to 48 hours after the abortion. If the afterbirth does not come away readily it should not be forcibly removed but the uterus should be irrigated once daily with a warm disinfectant solution. The irrigation of the vagina and uterus can best be done by using a soft rubber tube, one end of which is introduced into the vagina with a funnel in the outer elevated end. About one gallon of one-fourth or one-half per cent solution of creolin, lysol, liquor cresolis, or a solution of potassium permanganate (1 to 1000 solution) should be

introduced into the womb. This procedure should be practiced once a day for 10 days. After this, twice a week as long as the discharge continues. Cows that have aborted should not be bred again within a period of three or four months after the abortion occurred. The fœtus and the afterbirth of aborting cows contain innumerable bacteria, hence they should be burned or deeply buried. Unless this precaution is taken the infection will be carried from one place to another. Lime should be placed in the gutters to prevent the bacteria from spreading by surface drainage. Barns or stables that become infected should be thoroughly disinfected. The cattle should be removed and the barn left empty for four or five days. All bedding and litter should be removed and the walls and floors should be scrubbed and then sprayed with a strong disinfectant solution. One of the best disinfectants for stables is lime wash. To improve the germicidal properties of lime one may add six ounces of chloride of lime to every gallon of the lime wash. This mixture may best be applied by using a spray pump so that the disinfectant may be forced into the cracks and crevices.

The bull may be prevented from carrying the infection by disinfecting the penis and sheath before and after each service. The long hair around the opening of the sheath should be clipped and the surrounding parts bathed with a mild antiseptic solution.

In disinfecting the bull a small rubber hose will be found quite serviceable, one end of which is inserted into the sheath and held together by the hand so that the fluid will not immediately escape. In the other end of the hose a funnel is inserted into which the antiseptic solution is poured. In this way the sheath pouch may be easily irrigated. Mild antiseptic solutions should be used for this purpose. Infectious abortion may be suppressed by maintaining strict preventive measures.

Medicinal Treatment.—Many drugs have been used in the treatment of abortion but none have proved to be of much value. Certain drugs have been given credit for preventing abortion in given herds, yet, no doubt, the same results would have been obtained had no medicine been used. Carbolic acid and meth-

ylene blue have been used extensively in the treatment of abortion. Good results reported from the use of these drugs is probably due to the increased resistance or immunity to the disease which occurs after one or two abortions rather than the effects of the remedies themselves.

Immunization.—Cows after aborting once or twice become more resistant to the disease and carry the calf to the normal termination of pregnancy. In this way the disease will gradually exhaust itself, providing susceptible animals are not added to the herd. Because of the tendency toward natural immunity the problem of producing an artificial immunity presented itself. Living and dead cultures of abortion bacilli are being used in an attempt to produce artificial immunity in young heifers.

MILK FEVER (PARTURIENT PARESIS)

This is a disease peculiar to the cow, occurring at or near the time of calving. This disease as a rule confines itself almost entirely to the heavy milking breeds. Generally cows are afflicted at the third to fifth birth, although it may occur in cows bearing their first calf. Most cases occur during hot weather, and during rapid changes of weather. It may appear also during the coldest weather. Milk fever usually sets in from 24 to 48 hours after birth of the calf, the maximum interval being several days. It rarely occurs at the time of birth. Isolated cases have been observed just before calving, but never before the secretion of milk had begun.

Predisposing Causes.—Confinement in the stall predisposes to milk fever, partly because of lack of exercise, which is very essential in cows that are highly fed, and partly because of the air being hotter and at times impure.

Constipation may become an accessory cause by increasing the volume and density of the blood with certain material that should pass off by the bowels.

Mature age is a strong predisposing cause. The disease seldom, if ever, occurs with the first parturition and rarely with the second. It appears with the third, fourth, or fifth birth, when the cow has attained her normal growth and is converging all of her energies to the production of milk.

Calving is the chief predisposing factor. The manner in which it acts as an accessory has not been definitely determined, but is thought to be due to alteration in blood supply. It is after easy calving when there has been little expenditure of muscular or nervous energy that milk fever appears. Difficult parturitions which, as a rule, occur at the time of the first or second birth are rarely connected with parturient paralysis.

Symptoms.—Milk fever usually begins with signs of restlessness and occasionally signs of brain irritation may be observed in the beginning. After these initial stages, the characteristic signs of depression and paralysis appear (Figs. 69 and 70). First, the cow shows a weakness in the use of her hind parts; and steps unsteadily or staggers when attempting to move or walk, may fall and struggle to rise again. The cow no longer notices her calf or her feed. The weakness increases and the cow lies down or falls and is unable to regain her feet. The animal's temperature, which becomes sub-normal, may be slightly raised at this period. The cow may lie on her breastbone with her feet beneath the body, and her head turned round with the nose resting on the right or left, usually the left flank. In this position the cow appears to be asleep. In cases of extreme feebleness, the cow may lie on her side with all four legs stretched out. If an attempt is made to lift the head, it falls back powerless into its old position. The eyes appear glazed, and the pupils are widely dilated. The upper eyelid droops over the eyeball and is not moved when the eyeball is touched with the finger. At this time unconsciousness is usually complete. The tongue hangs loosely from the mouth, and breathing is performed with snoring, groaning, and rattling noises accompanied with great distention of the nostrils. The muscles of the bowels become paralyzed, causing obstinate constipation and at times bloating. This is usually accompanied by paralysis of the bladder muscles causing cessation of urination. If either or both of these organs continue to function, a favorable prognosis can usually be given. The temperature which may be raised at first becomes sub-normal. The pulse and heart-beats are quickened. The body temperature is unevenly distributed, the feet, ears, and horns being exceptionally cold to the touch.

Course.—The duration of the disease is brief and the results can usually be decided within a few hours.

Fig. 69.

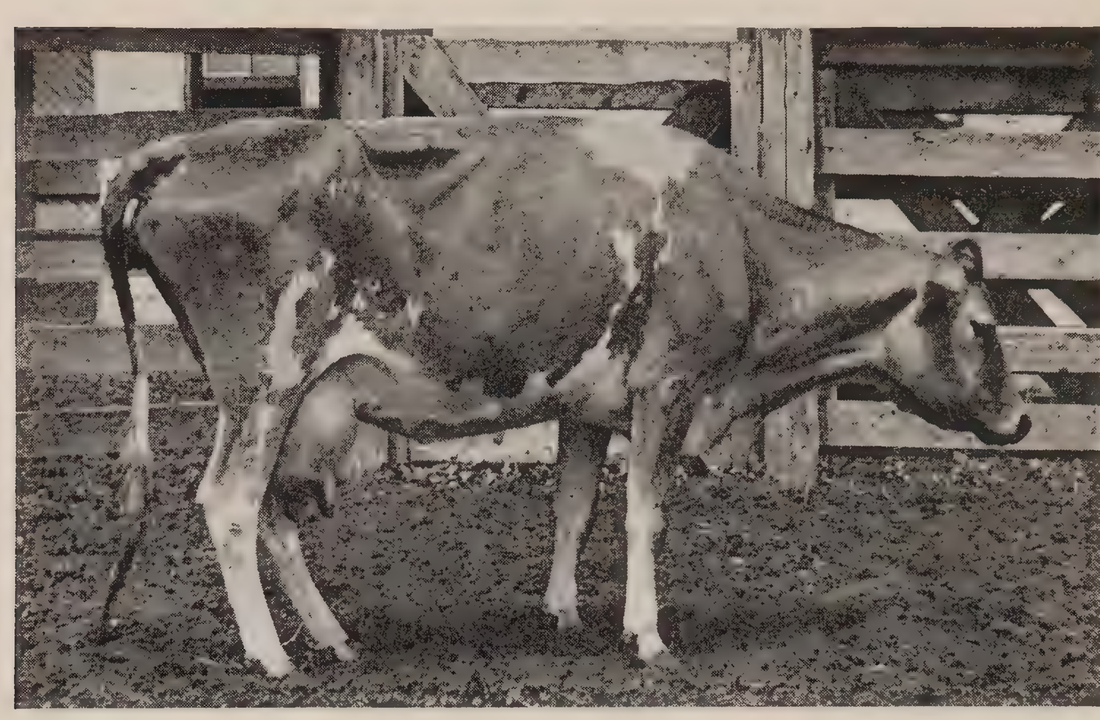

Fig. 70.

Fig. 69.—Cow, showing symptoms of milk fever in the first stage. (Courtesy of M. H. Reynolds.)

Fig. 70.—An advanced case of milk fever.

Preventive Treatment.—Heavy milking cows should be kept on a spare diet at least one week before calving and for four to five days after calving. Free access to salt and water are beneficial, as they tend to keep the bowels in good condition. One to one and one-half pounds of epsom salts may be administered twelve to twenty-four hours before calving. In case this procedure is neglected, salts should be given soon after the cow calves and the labor pains have ceased. Daily exercise is of much importance. Rich feeds should be avoided.

Another preventive measure consists of allowing the susceptible cow to retain in the udder for twenty-four hours following parturition all the milk except the quantity which is required by the calf, which amount should be taken, if possible, part from each quarter.

Air Treatment.—The treatment of milk fever by the injection of sterile atmospheric air into the udder has proved to be simple, practicable, and highly efficacious and results in no harm to the udder when properly performed. If antiseptic precautions are not observed and the injections performed in a careless way, disease-producing bacteria will often be introduced into the udder, causing mammitis (caked bag), a condition that may result in the loss of one or more quarters of the bag and at times in death. The method of injecting filtered air into the udder is a comparatively easy procedure, requiring but little time, and is readily accomplished by the use of milk fever apparatus. A milk fever apparatus is inexpensive and if cared for carefully will last for years.

Technique for Injecting the Udder with Filtered Atmospheric Air.—The teats and udder should be washed with soap and water, and then carefully disinfected with a three to five per cent solution of carbolic acid, lysol, creolin, or some other good antiseptic. A clean towel or sheet should then be placed under the udder to prevent the teats coming in contact with dirt or filth. The hands of the operator should be thoroughly washed with soap and water. The milking tube with the lower piece of hose of the milk fever apparatus should be boiled fifteen to twenty minutes before using. The milking tube is then inserted

into the opening of the teat and air is pumped into the quarter until it is sufficiently distended. Careful massage of the udder will allow the air to gain access to the innermost tubules. After the quarter is well distended, the tube is removed. The same treatment is applied to the other three teats until the udder is satisfactorily distended. In certain cases it will be found necessary to apply tape to the ends of the teats in order to keep the air from escaping. The pieces of tape should be removed within one or two hours so as to prevent sloughing. In case the air becomes absorbed, and no improvement is noticed within four or five hours, the treatment should be repeated, care being taken to observe the same antiseptic precautions as at first. The air may be left in the udder for twenty-four hours and when recovery is certain, it should be gradually milked out. The affected cow should not be allowed to lie on her side but kept up on the breast bone (sternum) so as to prevent the development of pneumonia.

Simple cases of milk fever, especially in the beginning, may be successfully treated by the layman provided he observes strict antiseptic measures. Skilled veterinarians should be employed, however, as they will obtain more satisfactory results. Especially is this true in the treatment of advanced and complicated cases.

FOOT AND MOUTH DISEASE

This disease is also known as epizoötic aphtha, aphthous fever, infectious aphtha, and may be defined as an acute, highly contagious disease, characterized by the eruption of vesicles or blisters in the mouth, around the coronary bands of the feet and between the toes. Foot and mouth disease does not confine its ravages among cattle but attacks almost as readily all other cloven-hoofed animals. Horses, dogs, cats, and poultry at times become infected and cases have been reported wherein man was the victim. Foot and mouth disease is common in European countries, where it produces great losses. The actual mortality produced is low. However, serious losses occur from the diminution of the milk secretion and the loss of flesh. Foot and mouth disease spreads very rapidly and infects a large number

of animals in a short period of time. Very little immunity is produced by foot and mouth disease, repeated attacks having been known to occur in the same animals.

Foot and mouth disease has appeared in the United States on six different occasions. The recent outbreak of 1914 was by far the most serious as well as the most extensive that has ever occurred in this country. All of the previous outbreaks were quickly and successfully eradicated.

Cause.—The causative factor of foot and mouth disease has never been isolated or identified, although numerous attempts have been made to discover the specific organism. The virus or the disease-producing material may be found in the blisters on the mouth, feet, udder and in the saliva, milk and various secretions and excretions, and in the blood, during the time when the temperature is high. Animals may become infected directly by licking, and in calves by sucking, or indirectly by infected hay, manure, drinking troughs, railway cars, stock-yards, barn-yards, and pastures. The time elapsing between the exposure of an animal to infection and the development of the disease in that animal varies usually from three to six days. The disease may appear in twenty-four hours, again in exceptional cases, not for eighteen days or longer.

Symptoms.—In foot and mouth disease the early symptoms consist of spells of shivering or chilling, quickly followed by fever, causing the body to become exceedingly warm. The body temperature may be as high as 105 or 106 degrees F. These symptoms do not always occur, or may be in so mild a form as to escape notice. Following this in one or two days, small vesicles or blisters about the size of a pea will make their appearance upon the mucous membrane of the mouth and tongue or on the lips or the margin of the dental pad. These small blisters are filled with a yellowish watery fluid and become more extensive as the disease progresses. Shortly after the eruptions have appeared in the mouth (Fig. 71), it will be noticed that there is considerable swelling and redness shown about the feet in the region of the coronet and between the toes. The formation of

vesicles or blisters soon appears upon the swollen regions of the foot. In milch cows the udder and especially the teats become affected with vesicles or blisters. As the disease advances the affected animal evidences considerable pain when attempting to eat and in some cases on account of great pain will refuse feed of all kinds. Salivation becomes excessive and the animal opens and closes its mouth with a characteristic smacking sound. The saliva is ropy and tenacious and hangs suspended from the lips. The vesicles which are small at first become extended and rupture soon after their appearance, leaving reddened painful spots or sores both within the mouth and upon the feet. Similar spots or erosions will occur on the teats of milch cows. All four feet of an animal may become affected at the same time. Again one or more of the feet may escape the infection and remain normal throughout the course of the disease. The affected feet become very sore and painful, causing the animal to lie down a great deal. The disease when assuming a mild form usually runs its course in approximately thirty days. In case of milch cows the return of the secretion of milk is greatly retarded. In the more destructive form of the disease several months or a year may be required for an animal to recover.

Diagnosis.—The foot and mouth disease is not difficult to recognize when it is known to exist in the vicinity. The services of experts, however, are required in order to recognize or diagnose the initial outbreaks. By inoculating calves with the virus from infected animals, the clinical diagnosis can be promptly and positively substantiated.

Diseases That May Be Confused with Foot and Mouth.—After the blisters or vesicles in foot and mouth disease rupture the disease becomes more difficult to recognize, as other diseases of a less contagious nature have a similar appearance. Cow-pox may at times be confused with foot and mouth disease, but in cow-pox the eruptions of the pocks which become pustules have well-marked and defined stages. The eruptions in foot and mouth disease never become more than a vesicle.

Necrotic Stomatitis (Sore Mouth Caused by Bacteria).—This disease may be differentiated from foot and mouth disease

by the fact that blisters do not occur in necrotic stomatitis and the ulcerated patches that appear in the beginning of the disease, principally involving the mouth and tongue, become covered with a yellowish, cheesy-like material. Calves are more apt to become affected with sore mouth than are adult cattle. Foot and mouth disease spreads more rapidly through a herd than does necrotic stomatitis and affects cattle of all ages, also sheep and swine.

Ergotism (poison from eating ergot) may be distinguished from foot and mouth disease in that the lesions occurring in

Fig. 71.—A cow affected with foot and mouth disease. Note the accumulation of saliva about the lips. (From report of the Bureau of Animal Industry.)

ergotism are confined to the ears, tail, and legs, usually below the knees or hocks. Vesicles or blisters do not occur in ergot poisoning, the lesions instead consisting of a dry-sloughing process. The tips of the ears will become dry and slough off. The tail may likewise become affected. The ankles swell considerably and later become circumscribed with a deep crack or fissure entirely surrounding the leg as a result of the sloughing.

Mycotic stomatitis (inflammation of the mouth caused by molds or fungi) is characterized by the formation of a croupous membrane or portions of the mucous lining of the mouth which

peels off, leaving a raw surface. The skin between the toes may at times become inflamed. The absence of vesicles on the udder and teats as well as other parts of the body together with the slowness in which the infection spreads in a herd aids in differentiating this affection from foot and mouth disease. Mycotic stomatitis appears usually in late summer or early fall and attacks from ten to fifty per cent of the animals in a herd.

Foul Foot (Foot Rot).—Foul foot is not an infectious disease, but during warm wet seasons a number of cattle may become affected in a certain district, giving rise to the suspicion on the part of some that it may be a disease of a contagious nature. Foul foot, as the name implies, is a disease of the feet only and the cause may be easily traced to filthy stalls and badly drained grounds.

Prevention of Foot and Mouth Disease.—The highly infectious nature of the disease and the easy manner of its dissemination require that rigid preventive measures be adopted to prevent its spread. Healthy cattle should be guarded carefully so as to prevent them being exposed to the infection. In a community where an outbreak occurs owners should exercise every precaution in preventing other animals, such as dogs, cats, and poultry, from coming in contact with the diseased animals, as they furnish excellent means for disseminating the causative factor. The carcasses of affected animals must be destroyed, preferably by burning or by burying them in a hole eight or ten feet deep and covering them with air-slaked lime, so as to prevent earthworms and similar agents from carrying the virus to the surface. Infected stables should be thoroughly disinfected with one of the following disinfectants: (1) a five per cent solution of pure carbolic acid. (2) Chloride of lime, U. S. P., one pound to three gallons of water. (3) Formaldehyde, one quart forty per cent solution to five gallons of water. (4) The application of lime wash to which is added chloride of lime in the ratio of six ounces of chloride of lime to each gallon of the lime wash is quite efficient.

All stable utensils must be thoroughly cleansed and disinfected with any of the above-named antiseptics. All manure should be burned or disinfected. The stables should not be

reoccupied within a period of sixty days following disinfection. The methods of eradication of foot and mouth disease as practiced by the United States Government consist of rigid quarantine, thorough disinfection and the purchasing and slaughtering of affected and exposed animals after proper appraisement.

LUMPY JAW (ACTINO-MYCOSIS)

This is a specific chronic infectious disease caused by a certain fungus (actinomyces) and characterized by the formation of tumorous masses in various parts of the body, more particularly the head. The history of this fungus is not known, but it is thought that it passes a part of its life cycle on certain grasses. The matured fungus has the appearance of a rosette and is commonly called "ray fungus."

Distribution and Extent.—Actino-mycosis or lumpy jaw is quite prevalent in the United States. The extent of the disease varies in the different states. According to the twenty-fourth annual report of the Bureau of Animal Industry there were slaughtered in establishments having federal inspection, 7,621,717 cattle, of which 22,742 were found to be affected with lumpy jaw. The actual percentage is even greater, for numerous animals affected with this disease are slaughtered where there is no official inspection maintained.

Source of the Fungus.—The fungus which causes the disease is probably most frequently obtained from vegetation, especially wild rye, barley, oats and other grains. Infection is thought to occur most often in animals fed on dry feed such as fodder, straw, or hay. It is questionable as to whether the disease may be transmitted directly from one animal to another, although certain instances have been recorded wherein the infection apparently spread by actual contact.

The causative fungus may gain entrance to the animal body by way of the digestive tract, the respiratory tract or through the skin. The digestive tract is the most frequent channel of entrance in cattle. Wounds of mucous lining of the mouth, diseased teeth, or the shedding of milk teeth, provide an entrance for the causative fungus. The upper surface of the tongue, which is often injured by rough feeds, frequently affords

an entrance for the ray fungus. When the disease affects the tongue it is commonly known as "wooden tongue." Wounds of the skin resulting from rubbing on stanchions and feed boxes may be a source of infection in some instances. Infection by way of air passages is not of common occurrence.

Location of the Disease.—The disease may be located both externally and internally. The fungus may invade and produce the disease in any tissue. It is most often found affecting the soft tissues and bones of the lower and upper jaw. Internally it may attack the tongue, pharynx, or larynx. It may also affect the lungs and more rarely the digestive tract; occasionally the udder is attacked. It is usually localized, and rarely if ever becomes generalized. When affecting the soft tissue of the head the disease produces rather hard, firm swellings (abscesses) (Fig. 72), which vary in size, surrounded by a thick dense capsule. The abscesses tend to rupture finally and discharge a thick creamy pus. The pus contains small yellow bodies, which are commonly known as "sulphur granules." These are the "ray fungi." After the abscess has ruptured, the cavity does not disappear but is soon filled with fungus-like masses which protrude outward through the opening. In some instances the abscesses will appear in the form of a chain, extending along the jaw and upper portion of the neck. When the abscesses form inside the throat, they seriously interfere with swallowing and respiration. Actino-mycosis of the bone is of common occurrence and must be regarded as one of the most serious forms of the disease. The bone becomes disintegrated and pockets or cavities are formed. As the diseased process advances, there is new bone tissue formed, causing the bone to become enlarged and have a honeycomb appearance.

The disease of the tongue, "wooden tongue," is also a very serious form of the disease, as it interferes with the movement of this important organ of mastication. The course of the disease is quite slow. Emaciation in the affected animal results when mastication, rumination, or breathing is affected. The tongue and the bones of the jaws may become so badly diseased that death will result from starvation.

Treatment.—When affected the soft structures of the lower

and upper jaw may be satisfactorily treated, but when the bony tissue is diseased treatment is of less value. Potassium iodide, administered in the form of a drench once a day until symptoms of iodine poisoning occur, has proved to be quite beneficial in the treatment of this disease. Abscesses located externally in the region of the head and neck require early attention in order to effect a cure. Operations of this kind can only be undertaken by skilled veterinarians.

FIG. 72.—Cow badly affected with lumpy jaw, unthriftiness due to the mechanical difficulty in eating. (Courtesy of M. H. Reynolds.)

INFLAMMATION OF THE UDDER

Mammitis is the veterinarian's name for inflammation of the udder. Aggravated cases of garget may at times terminate in active inflammation. Mammitis may occur also directly in connection with injuries, such as blows on the udder with clubs, horns, or feet, or from nails in the floor. Over-feeding, exposure to extreme changes of weather, indigestion, and insufficient stripping of the udder during milking may also cause the udder to become inflamed.

Symptoms.—In cases of mammitis following exposure, the early symptoms noted consist of spells of shivering. The tail,

ears, and limbs become cold and the hair in general is erect. This condition is soon followed by fever and the body becomes unnaturally warm. The muzzle becomes hot and dry, the temperature rises, rapid pulse, excited breathing, impaired appetite, cessation of rumination, and constipation. The udder swells and becomes hard in one, two, three, or all four quarters and the yield of milk is greatly lessened, at times becoming entirely suppressed in the affected quarter or quarters. As the inflammatory process extends, the udder becomes painfully tender, causing the animal to straddle with its hind legs when walking. In cases where the supporting tissue or framework of the udder is inflamed, the swelling is rounded and uniform and pits on pressure. In cases where the secreting portion of the gland becomes inflamed, the swelling is more localized and appears as hard, nodular masses, deep in the gland. In all cases the milk is suppressed and replaced by a watery fluid which is at times streaked with blood and mixed with clots of casein. Later it becomes thickened and is usually accompanied by an offensive odor, due to pus formation.

The course of the disease varies, some cases lasting only a few days, while others will last several days or even weeks before the inflammation has subsided and the gland restored to its normal condition. Many cases terminate in complete recovery. Others result in only partial recovery with arrested secretion in one or more quarters. When this occurs, the affected portion shrinks to a smaller size. In quite a number of cases, hard, fibrous masses result, which cause permanent induration (hardening). In other cases abscesses (boils) will develop. The abscess may empty itself on the external surface or it may break into the milk ducts and be discharged through the teats.

Treatment.—Treatment will be found to vary in accordance with the stages of the disease.

Internally, laxatives are indicated. Epsom salts, one to two pounds, with an ounce of ginger dissolved in a quart of water and administered as a drench, will be found efficacious. After the purgative action has ceased, one ounce of saltpeter may be given once a day. Local treatment consists of hot fomentations and gentle but frequent massage. Cloths wrung

out of warm water should be applied to the udder for an hour or two at a time. The application of camphorated vaseline or lard may be used with good effect. In case of abscess formation early lancing is recommended. Frequent milking is necessary in order to get the best results and the affected cow should be milked at least five or six times a day.

GARGET

This is a condition that often occurs in heavy milkers just before or after calving. The udder becomes enlarged and is hot and tender. At times a doughy swelling will be noticed to extend from the udder forward along the lower surface of the abdomen. This condition is physiological and the congestion usually disappears within a few days after the secretion of milk begins. Garget becomes aggravated when the animal is allowed to stand in a draft of cold air or when compelled to lie on unprotected cold cement or on wet floors. Incomplete milking is probably the most frequent cause of garget even with cows far along in milk. In some cases doughy swellings will occur on the surface of the gland and the milk may be tinged or streaked with blood and is usually stringy and clotted when drawn. Such milk is unfit for food, but one gargetty quarter does not spoil the milk of the remaining three quarters.

Treatment.—The affected animal should be placed in a dry, clean, and well ventilated stall and the udder lightly massaged with the finger-tips. The application of hot cloths around the affected parts aids in restoring proper circulation and in this way prevents or wards off inflammation. The application of turpentine and lard, or, better still, camphorated vaseline, will be found beneficial, and will aid materially in restoring the gland to its normal condition. The administration of epsom salts as a laxative is advised, especially in cases where the bowels are inclined to be sluggish.

COW-POX

Cow-pox is an infectious disease of the udder, characterized by inflammation and the formation of vesicles or blisters which undergo certain well-marked changes. The disease spreads

very slowly from animal to animal, but will spread readily by the hands of the milker. Cow-pox is very closely associated with human small-pox.

Cases of cow-pox have been reported to occur in cows that had been milked by persons affected with small-pox. Young, healthy calves are used for the production of small-pox vaccine.

Cause.—The cause of cow-pox has not yet been determined. It is thought to be due, however, to germs (bacteria) which are ultra-microscopic, too small to be seen by aid of the microscope.

Symptoms.—Cow-pox is usually accompanied by a slight elevation of temperature. This condition is not, however, always constant. The age of the cow is an important factor in making a diagnosis, as the disease affects chiefly young cows. The milk flow may or may not be decreased. The eruptions of the vesicles (blisters) occur on the teats and the adjoining parts of the udder. The development of the pocks are divided into well-marked characteristic stages. The first stage of the eruption consists of pink-colored pimples about the size of a pea. The pimple subsequently changes into a blister which contains a sticky, whitish fluid. The blisters on the teats vary in form, while the ones on the udder are circular and show a depression in the center. The blisters vary in size, some measuring as much as one-half to one inch in diameter. When the pocks occur on the surface covered with long hair, they do not form blisters, but discharge a straw-colored fluid which cements the hair and forms a brownish-yellow mass. The blisters mature about the tenth day and then dry up into a dark brown crust which drops off a few days later, leaving a scar. Many of the pocks are ruptured during milking, causing the frequent formation of angry-looking sores which heal slowly. Only in rarer cases does the disease affect other parts of the body.

Treatment.—Local treatment is all that is required. A separate attendant should be provided to care for the diseased animals. They should be milked carefully so that the blisters will not become ruptured. The persistent sores may be washed with mild antiseptic solutions. The attendant should keep his hands and arms washed with an antiseptic. Application of zinc oxide ointment to the ruptured pocks will be beneficial.

CHAPPED TEATS

The condition, chapped teats, is quite common during the winter season and is due to excessive local irritation of the teats. The sucking of the calf, and sudden chilling of the teat after the calf has finished, will often produce a chapped condition. Cows kept in cold, damp stalls often suffer from chapped teats due to the teats and udder coming in contact with water and filth when the cow is lying down. Sudden exposure to cold after the completion of milking with wet hands will also cause this condition. Chapped teats may be either mild or severe in form, depending upon the amount and the nature of the irritant. In mild cases the fissures (cracks) are small, and the flow of milk is unaltered, while in severe cases the fissures may form large gaping wounds (sores) which, at times, will cause a retention of the milk and even inflammation of the udder (mammitis).

Treatment.—The affected animal should be placed in a clean, dry, warm stall, and great care should be exercised when milking so as to allow the wound to heal. The use of vaseline is recommended because of its soothing effect on the chapped areas. In cases where healing is tardy, the application of mild antiseptic solution will be found beneficial.

WARTS (PAPILLOMATA)

Treatment.—Warts may be greatly benefited or entirely are frequently located on the surface skin of the teats. They are not only unsightly, but often become very troublesome. Warts occurring on the teats of heifers are essentially benign and as a rule respond readily to treatment.

Treatment.—Warts may be greatly benefitted or entirely removed by the application of pure olive oil, the oil being generously smeared over the surface of the warts after each milking. Persistent warts require surgical interference.

BLOATING (HOVEN)

This is a disease characterized by swelling or distention of the left flank, and is caused by the formation of gas in the rumen or paunch.

Causes.—Some animals are predisposed to bloating by the habit of over-eating or eating too quickly. The chief cause, however, is the introduction into the stomach of large quantities of feed which ferments and produces great volumes of gases. Bloating is caused most frequently by eating green feed. It is also caused by sudden changing from dry fodder to green corn, by feeding on rank, luxuriant grass or clover, wet or frozen roots, rotten potatoes, or by allowing cattle to drink large quantities of water soon after feeding. Bloating caused by eating young clover is quite common, occurring mostly when the cattle are first allowed to feed on it. Clover is not so apt to produce bloating after it has blossomed. Calves suffering from indigestion often develop hoven.

Symptoms.—The chief and characteristic symptom of bloating consists of a swelling in the region of the left flank, from which a drum-like sound is emitted when struck with the finger-tips.

The normal sounds of the rumen cease and the appetite and rumination (chewing of the cud) are suspended. Frequent passages of small amounts of manure occur at first, but gradually cease until no further passages are noticed. The animal has an anxious expression, moves uneasily, as if in great distress, the back is frequently arched and the breathing is rapid and difficult. As the bloating increases, the breathing becomes more laborious and the animal experiences great difficulty in retaining its equilibrium, and if not relieved within a short time, falls down and suffocates. Frothing at the mouth, together with occasional belching of gas, are frequent symptoms.

Course of the Disease.—The course of acute bloating is very rapid. If the rumen is only moderately distended the animal may recover unaided, while in severe cases the animal may die in an hour or so if not relieved.

Treatment.—As regards prevention, one should avoid the sudden changing from dry to green feed, and cut green feed should not be fed after it has begun to ferment. Cattle should be allowed to pasture only for a short time on clover, at first, and the feeding of frozen, watery feeds should be avoided,

Mild cases of hoven may be successfully treated by placing a rope or straw band smeared with tar or some other nauseous material in the animal's mouth, securing it by tying behind the horns. Vigorous massage on the left flank tends to relieve the distended paunch and is practiced with good results in cases which are not severe. In severe cases the trocar and cannula should be used without delay. To puncture the rumen (paunch) a spot should be selected that is equally distant from the last rib, the hip-bone, and the transverse processes of the lumbar vertebræ (Fig. 73). The trocar should be held so that the sharp point is directed downward, inward, and slightly forward when by a sharp blow with the palm of the hand it is plunged into the paunch. A previous incision about one-half inch in length through the skin makes the operation easier. The cannula or sheath of the trocar should be allowed to remain in the paunch as long as any gas escapes from it. If the cannula is removed while gas is still forming in the paunch it may become necessary to insert it again. In obstinate cases it is sometimes necessary to leave the cannula in the paunch for several hours. When a trocar is not obtainable, the operation may be performed with a knife. After the bloating has subsided, it is advisable to drench the animal with a pound or a pound and one-half of epsom or Glauber salts. A recent bulletin issued by the Kentucky Station recommends the use of formalin for the treatment of bloat, when caused by clover. They advise drenching the affected animal with one quart of a one and one-half per cent solution of formalin in water.

SIMPLE DIARRHEA (SCOURING) IN CALVES

Scours in calves is a rather common disease and is usually caused by improper diet. The disease, white scours, is infectious in nature and while occurring quite often, is not nearly so common as the simple form.

Causes.—Simple scouring is a common result of indigestion caused by a too liberal supply of milk or too rich milk. Scour-

ing often results from allowing too much time between meals. Unhygienic conditions, such as dirty, sour drinking tanks or dark, cold, damp or foul-smelling stalls or pens, tend to produce scours. Faulty weaning, such as too early feeding on dry, coarse feed and feeds that contain large amounts of starchy material, are causative factors. The physical condition of the cow bears a close relation to the health of her suckling and care should be used in providing her with proper feed and care so

Fig. 73.—The × indicates the point where the wall of flank and rumen are punctured with trocar and cannula in "bloat."

as to prevent the quality of the milk from becoming impaired, and the quantity diminished.

Intestinal parasites (worms) may at times produce diarrhea by irritating the mucous lining of the stomach and intestines.

Symptoms.—The symptoms usually occur suddenly, although they may come on gradually. In sucklings, the symptoms of diarrhea (scouring) may be preceded by: De-

pression, weakness, and disinclination to suck. When the disease is due to improper diet or exposure, symptoms of chilling followed by fever will be noticed. The body temperature is unevenly distributed, the legs being cold and the muzzle dry. The diarrhea which soon sets in consists of rather pasty manure of normal color and odor, at first, but rapidly becomes watery and is light gray in color accompanied by a peculiarly characteristic and offensive odor. As the disease advances, the passages become numerous, and the tail and legs become stained with the dung which clings to the hair and skin. The dung will be frequently passed in the form of a jet or liquid stream. Bloating is commonly noticed; and colicky symptoms are not rare. Toward the end, the animal stands with its back arched. The skin becomes dry and the odor given off by the various channels is very offensive, and the animal becomes weak and listless. During the later stages the dung at times becomes streaked with blood. The course of the disease may be acute or chronic. The affected animal may die within a few days or may live for several weeks. When death occurs, it is usually due to exhaustion and lung complications (pneumonia).

Prevention.—When diarrhea occurs in the suckling, the treatment should be mainly applied to the mother. The cow should be supplied with a proper diet and all factors which unfavorably influence the quality of the milk should be removed. In case the mother is suffering from disease, the calf should be permitted to suckle a healthy cow. When diarrhea is due to improper feeding, the error should be corrected immediately. Hygienic measures such as proper light, ventilation and cleanliness applied to calf pens, tend to keep the calf in good health and prevent disease. Exercise is also of much importance. Calves fed from pails are in danger of developing scours, unless absolute cleanliness is maintained. The feeder has to be on the alert also so as to prevent greedy calves from drinking an over-amount of milk.

Treatment.—The early administrations of laxatives are indicated in order to remove irritating substances from the bowels. For this purpose, castor oil in one or two-ounce doses is recom-

mended. The calf's ration of milk should be reduced one-half, and in cases where the milk does not agree with the affected animal, barley gruel to which raw eggs are added, may be substituted. A mild solution of formalin, which is mixed with the milk, is quite efficacious for the treatment of this disease.

RINGWORM (BALD SCAB)

Ringworm is a highly contagious, transmissible disease of the skin caused by a vegetable parasite (Tinea Tonsurans). This disease affects the root and shaft of the hair, causing it to become brittle and finally fall out. Calves are commonly affected, especially during winter and spring.

Ringworm is communicable to man.

Symptoms.—Ringworm is manifested by the formation of circular hairless patches, on the skin of the head, neck and extremities. The patches vary in size, some being about the size of a pea, while others will measure an inch or more across. The patches or spots are usually scattered, although they may run together, forming large ones. The skin becomes slightly inflamed and the exudate, which is of a sticky nature, forms dry, brittle and scaly crusts of a greyish color. Occasionally the entire skin of the body will become affected, which may result in complete nakedness. In sucking calves the patches form mainly around the mouth. The disease is attended by itching which is manifested by rubbing in the affected animal. Any animal so affected is uncomfortable, restless and does poorly.

Treatment.—Preventive measures consist of removal of affected animals, cleaning and disinfection of stalls. The affected patches or spots should be washed with soap and water so as to remove all crusts and after drying, tincture of iodine may be applied by painting the diseased areas. The treatment may be applied once daily. If attended to faithfully recovery should be complete in four to six weeks.

1. How general is the disease, bovine tuberculosis?
2. How is its presence detected?
3. What dangers to the herd would result if one tubercular cow were allowed to mingle freely with the herd?
4. What is tuberculin used for?
5. What is infectious abortion?
6. What are its symptoms?
7. How does abortion affect the milk flow following?
8. How is the disease spread?
9. What means may be taken to prevent its spread?
10. How should an aborting cow and the dead calf be handled?
11. What treatment is recommended for the affected animal?
12. What is milk fever?
13. What are its symptoms (signs)?
14. How should a case of milk fever be treated?
15. How should a heavy milking cow be handled to reduce the danger of milk fever to the least possible point?
16. How damaging is the foot and mouth disease?
17. What are the symptoms of this disease?
18. How is it spread?
19. What means should be taken to check an epidemic?
20. What is ergotism?
21. What conditions bring about foul rot in the feet of cattle?
22. What are the symptoms of mammitis?
23. What causes the trouble?
24. What is the best treatment for it?
25. What treatment is advised for garget?
26. How is cow-pox spread? How cured?
27. How should chapped teats be cared for?
28. What may be done to remove warts on cows' teats?
29. What brings on hoven in cattle?
30. What is the best treatment?
31. What conditions of feed cause scours in calves?
32. What conditions in stalls or pen aggravate the case?
33. How should calves suffering with common scours be handled?
34. How may ringworm be cured?

PART IV

WINTER FEEDING

CHAPTER XXIII

WINTER FEEDING OF DAIRY COWS

Of all the problems confronting the keepers of the twenty-two million cows in America kept for dairy purposes, adequate and proper feeding is the most important at the present time. Possibly because of the great variety of conditions and feed stuffs, the knowledge of the best methods of feeding has been very slow of development. Many discouraging statements have been made regarding the productive capacity of the "average" cow in the United States. It is true that the average yield is far below the amount obtained by the good dairy cows and only a fraction of that produced by the few outstanding leaders. This difference is not by any means wholly due to the incapacity of the cows themselves to do better work. The fact that many of them are miserably under-fed and often housed in uncomfortable quarters has much to do with the situation. In an endeavor such as inducing cows to give more milk, one will not go far wrong if one will study the cows' requirements on the basis of what they receive when doing their best work and then imitate or duplicate as nearly as possible those conditions the year round.

Copy Nature.—Cows, while living under a more or less wild condition, usually freshen in the early spring and produce the greatest flow of milk during the latter part of May, June, and the first half of July. By studying the conditions of this season of the year and desiring to duplicate them at a season when butter fat is most valuable per pound and when field work is light or lacking altogether, we may find a way to more profit.

Analyzing the question we note that there are several factors influencing the returns.

Time of Calving.—Although cows may be said naturally to calve in the spring, they very readily adapt themselves to fall calving. In this respect then we may arrange for a spring-time flow of milk in winter.

Comfort of body, present in the early summer to the greatest degree, is essential to liberal production. In order that the cow under artificial circumstances shall be as productive as her inherited nature will permit, complete comfort, both in temperature of stable and in sleeping quarters, is necessarily required for winter.

Very comfortable stables are now in use and becoming more common. The temperature of summer may be closely duplicated in winter.

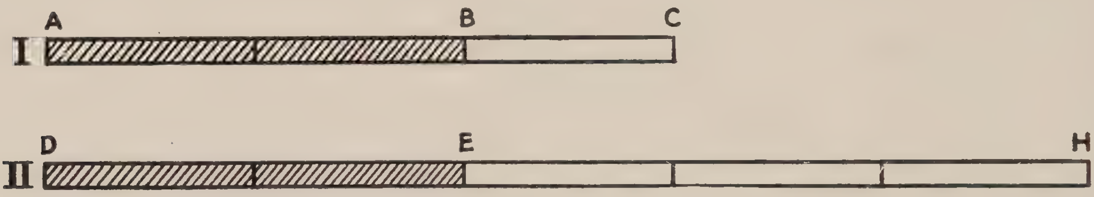

FIG. 74.—Illustrating the economy of liberal feeding.

Abundance of Feed.—Even with the heavy stocking of pastures practiced in many parts of the country there is usually a great abundance of feed for the cows for a few weeks and it is observed that during this period of abundance the cows yield milk most liberally and we find that logic, experience and scientific findings all agree that any animal, to produce freely, must be freely fed. The value of mere abundance of feed may be well illustrated in the diagram (Fig. 74) in which let the upper bar indicated by the length of the line A C be the amount of feed given to cow No. 1, and the lower line D H, the amount of feed given to cow No. 2, of equal weight and form. These two cows, for the maintenance of their bodies, will consume or burn daily a quantity of feed represented by the distances A B and D E, respectively. The maintenance amount of feed is a fairly constant quantity.

It is evident that cow No. 1 will have a balance of feed over and above the amount for maintenance represented by the short line B C, whereas Cow No. 2 receives the amount of surplus feed presented by the line E H, the same being three times as

great as B C. Cow No. 2 has not received three times as much feed by any means, but the surplus remaining for milk formation after maintenance has been subtracted, is three times as great. It is evident, therefore, that the first portion of the feed given to a cow is essentially wasted unless an additional amount is given from which milk may be formed. Cows do not create the substance of milk, they merely change its form from that of grass, hay and grain to that of milk sugar, milk fat, casein, albumen and ash. The Scotch have a saying, " Give to a steer a gallon of meal and it is a gallon wasted, give him two and he will pay for three." There is truth in it.

Palatability.—Mere abundance, however, is not all the animal needs by any means. A cow might be tied to a straw stack and starve to death. In addition, the feed must be palatable in order to be consumed in sufficient quantities and be most valuable. Feed eaten with repugnance might often better have remained uneaten so far as any good to the animal is concerned.

Fresh grass is about the most palatable feed to cattle and large quantities are eaten while it is tender. Winter hay may often be made more valuable by sprinkling it with salty water or molasses water to make it more palatable.

Succulence is unquestionably one of the qualities of early summer grass which materially assists the cow in heavy production. This quality in the winter's feed may be provided in ample measure in the form of corn silage or, when such is not available, in the form of mangles, ruta-bagas, or other roots, or potatoes. The succulent quality in feed is of value in several ways. The cow is induced thereby to consume a larger amount and that which she does consume is more easily masticated and more easily and economically digested, thus more valuable per unit of feed material present. If to the succulent quality there can be retained or added the flavors particularly relished by cows, such for instance as well made corn silage, the digestion of these feeds is facilitated by the fact. Over ripe hay and dry corn stover are so hard that their net value to the animal is only a half or less of the apparent value as indicated by a table of digestible nutrients.

One value of the silo is that by its means the corn is not only cut fine and some chewing thus saved, but it is soaked soft and mellow, assisting the cow in the work of reduction (Fig. 75).

Balance of Nutrients.—One of the most important features influencing the matter of large and economical yields of milk is the balance of the nutrients in the feed given. It is in this phase of the subject that most feeders make the most serious mistakes. The need of any mature cow for feed may be briefly stated as the demand for small quantities of various ash materials to maintain the bone of the body, to furnish ash to the milk, and for other purposes. The quantity and nature of the ash are nearly, if not quite, amply provided by a mixed rough-

Fig. 75.—Art and utility may be successfully combined. Dairy stable and two silos belonging to E. H. Sears.

age and grain ration, especially if a small quantity of bone meal is mixed with the cow's salt. The cow, however, contains large quantities of muscular tissue or lean meat which is slowly but continually wearing out and being voided from the system. To make good this loss, materials of like character must be provided. Lean meat is composed very largely of proteins. Plants contain protein, not of identical character, but similar, and under normal conditions it is only from the plant protein that animal tissue is built. Milk contains about 3.50 pounds protein in every 100 pounds. Cows, therefore, require especially liberal amounts of protein in their rations.

A third element required is heat and energy. Some heat is

obtained from the protein nutrients, but it is needed in such amount that to provide all of it in the form of protein would be too expensive and injurious to the cow. The starchy and sugary portions of feeds provide energy and heat most cheaply. The fat or oil of corn, hay or other feeds goes, likewise, to the supply of heat and energy. But since the heating power of a feed nutrient is indicated largely by the percentage amount of carbon in its compound, and fat is so much richer in this element than starch or sugar, it, fat, has about 2.25 times more heating power than starch. The fat of the animal body is not necessarily made from the fat of plants but oily feeds naturally encourage the laying on of fat. For convenience the purely heat and energy-bearing feeds, such as starch and sugar, are called carbohydrates, while all fats are grouped by themselves.

It is customary to classify all needed feed nutrients as protein, carbohydrate and fat. These are the three constituents which we must provide in the cow's winter ration if she is to yield milk in winter as freely as in summer.

The maintenance ration is the name given to the amount of feed which is required to just sustain the weight of an animal for twenty-four hours. On a perfect maintenance ration an animal will neither gain nor lose weight. The amount of feed needed by large cows is naturally greater than that required for small ones, and that by very active animals greater than for slower motioned ones. Just how much of the three digestible nutrients, protein, carbohydrates and fats, a cow of 1000 pounds' weight requires was studied first in Germany, but the figures obtained there were too high to be accurate under American conditions.

The standard now most largely used in this country is the one settled upon by Haecker of the Minnesota Station after many years of careful work and is as follows: Digestible protein 0.7 pounds, digestible carbohydrates 7.0 pounds, and digestible fat 0.1 pound per 24 hours, for an average cow of 1000 pounds, where kept under good practical stable conditions.

The following table gives the nutrients allowed daily for the maintenance feed for cows of given weights, ranging from 800 pounds to 1625 pounds.[1]

[1] Minn. Bul. 130.

Table I. Feed of Maintenance

Weight	Protein	Carbohydrates	Fat	Weight	Protein	Carbohydrates	Fat
800	.560	5.60	.08	1225	.857	8.57	.12
825	.577	5.77	.08	1250	.875	8.75	.12
850	.595	5.95	.08	1275	.892	8.92	.13
875	.612	6.12	.09	1300	.910	9.10	.13
900	.630	6.30	.09	1325	.927	9.27	.13
925	.647	6.47	.09	1350	.945	9.45	.13
950	.665	6.65	.09	1375	.962	9.62	.14
975	.682	6.82	.10	1400	.980	9.80	.14
1000	.700	7.00	.10	1425	.997	9.97	.14
1025	.717	7.17	.10	1450	1.015	10.15	.14
1050	.735	7.35	.10	1475	1.032	10.32	.15
1075	.752	7.52	.11	1500	1.050	10.50	.15
1100	.770	7.70	.11	1525	1.067	10.67	.15
1125	.787	7.87	.11	1550	1.085	10.85	.15
1150	.805	8.05	.11	1575	1.102	11.02	.16
1175	.822	8.22	.12	1600	1.120	11.20	.16
1200	.840	8.40	.12	1625	1.137	11.36	.16

Ration for Milk Production (The Haecker Feeding Standard).—For many years the only available standard or guide in feeding for milk production was that of Wolf, later modified by Lehmann, which standard took into account only roughly the amount of milk yielded per day and no account at all of the quality of the milk.

The following table from Minnesota Station Bulletin 130 shows that as milk increases in fat percentage it also increases in protein and sugar.

The comparative value or cost of milks of various fat percentage is best shown by reducing all the nutrients to a single term called the Starch Equivalent. This is obtained by multiplying the amount of fat by 2.25 and adding to the product the amount of Protein and Carbohydrates.

The following table makes this matter clearer. A glance at the table convinces one that to feed amply and yet not waste, full account needs be taken of the quality as well as the quantity of the milk being produced by the cow being fed.

Organic Composition of Milk[2]

Fat	Protein	Carbohydrates	Starch Equivalent
3.0	2.68	4.60	14.03
3.5	2.81	4.75	15.44
4.0	3.08	4.85	16.93
4.5	3.27	4.97	18.37
5.0	3.45	4.98	19.68
6.0	3.82	4.91	22.23
6.5	4.12	4.90	23.65
7.0	4.22	4.84	24.81

This has now been carefully worked out and published in Minnesota Station Bulletin 130, from which the following tables are taken.

A number of feeding standards have been suggested, but the one developed by Haecker, of the Minnesota Station, is the most workable. Haecker was the first investigator to consider the maintenance of the cow separate from the milk, to recognize the quality of the milk as well as the quantity, and to reduce the whole to a unity basis.

Adjusting the Ration.—There is what may be called a triple balance in the matter of feeding dairy cows, (*a*) the balance of the amount of roughage to the size of the cow, (*b*) the balance of the amount of grain to be fed to the amount and quality of the milk the cow is giving, and (*c*) the balance of the chemical nutrients to the needs of the cow.

On the average a cow will eat 2 pounds of hay or its equivalent per hundred pounds per day. A cow weighing 900 pounds will eat 18 pounds of hay very readily and one of 1400 pounds should consume 28 pounds of hay per day. Ordinarily, however, the lighter weight cows, if they are of dairy type, will eat more for their weight than heavier ones. Where corn silage is fed due allowance must be made for the high water content of it.

Silage as now usually made from comparatively mature corn contains about 26 per cent dry matter, thus 3 pounds will contain 0.78 pound dry matter, which is roughly the equivalent of 1 pound of hay (0.87 pound of dry matter).

[2] Minn. Bul. 130.

TABLE II. FEEDING STANDARD

Giving Net Nutrients Required for the Production of Milk Containing a Given Per Cent of Butter-Fat

Lbs. of Milk	% FAT IN MILK 3.0			% FAT IN MILK 3.1			% FAT IN MILK 3.2		
	Pro.	C-H.	Fat	Pro.	C-H.	Fat	Pro.	C-H.	Fat
1	.047	.20	.017	.047	.20	.017	.048	.21	.018
2	.094	.40	.034	.095	.41	.035	.096	.41	.036
3	.141	.60	.051	.142	.61	.052	.143	.62	.053
4	.188	.80	.068	.190	.81	.070	.191	.83	.071
5	.234	.99	.085	.237	1.01	.087	.239	1.04	.089
6	.281	1.19	.102	.284	1.22	.104	.287	1.24	.107
7	.328	1.39	.119	.332	1.42	.122	.335	1.45	.125
8	.375	1.59	.136	.379	1.62	.139	.382	1.66	.142
9	.422	1.79	.153	.427	1.83	.157	.430	1.87	.160
10	.469	1.99	.170	.474	2.03	.174	.478	2.07	.178
	3.3			3.4			3.5		
1	.048	.21	.018	.049	.22	.018	.049	.22	.019
2	.097	.42	.036	.097	.43	.037	.098	.44	.038
3	.145	.64	.054	.146	.65	.055	.148	.66	.057
4	.193	.85	.072	.194	.87	.074	.197	.88	.076
5	.241	1.06	.090	.243	1.08	.092	.246	1.10	.094
6	.290	1.27	.109	.292	1.30	.111	.295	1.32	.113
7	.338	1.48	.127	.340	1.51	.129	.344	1.55	.132
8	.386	1.69	.145	.389	1.73	.148	.394	1.77	.151
9	.435	1.91	.163	.437	1.95	.166	.443	1.99	.170
10	.483	2.12	.181	.486	2.16	.185	.492	2.21	.189
	3.6			3.7			3.8		
1	.050	.22	.019	.051	.23	.020	.052	.23	.020
2	.100	.45	.039	.102	.46	.039	.104	.47	.040
3	.150	.68	.058	.153	.69	.059	.156	.70	.060
4	.200	.90	.077	.204	.92	.078	.208	.93	.080
5	.250	1.13	.096	.255	1.15	.098	.260	1.17	.100
6	.301	1.35	.116	.307	1.38	.118	.312	1.40	.120
7	.351	1.58	.135	.358	1.60	.137	.364	1.64	.140
8	.401	1.80	.154	.409	1.83	.157	.416	1.87	.160
9	.451	2.03	.174	.460	2.06	.176	.468	2.10	.180
10	.501	2.25	.193	.511	2.29	.196	.520	2.34	.200
	3.9			4.0			4.1		
1	.053	.24	.021	.054	.24	.021	.055	.25	.021
2	.106	.48	.041	.108	.48	.042	.109	.49	.042
3	.159	.71	.061	.162	.73	.062	.164	.74	.063
4	.212	.95	.082	.216	.97	.083	.218	.99	.084
5	.265	1.19	.102	.269	1.21	.104	.273	1.23	.105
6	.318	1.43	.122	.323	1.45	.125	.328	1.48	.127
7	.371	1.67	.143	.377	1.70	.146	.382	1.73	.148
8	.424	1.90	.163	.431	1.94	.166	.437	1.97	.169
9	.477	2.14	.184	.485	2.18	.187	.491	2.22	.190
10	.530	2.38	.204	.539	2.42	.208	.546	2.47	.211

TABLE II. FEEDING STANDARD—*Continued*

Lbs. of Milk	% FAT IN MILK 4.2			% FAT IN MILK 4.3			% FAT IN MILK 4.4		
	Pro.	C-H.	Fat	Pro.	C-H.	Fat	Pro.	C-H.	Fat
1	.055	.25	.021	.056	.25	.022	.056	.26	.022
2	.111	.50	.043	.112	.51	.044	.113	.52	.044
3	.166	.75	.064	.167	.76	.065	.169	.78	.067
4	.221	1.00	.086	.223	1.02	.087	.226	1.04	.089
5	.276	1.25	.107	.279	1.27	.109	.282	1.30	.111
6	.332	1.50	.129	.335	1.53	.131	.339	1.56	.133
7	.387	1.76	.150	.391	1.78	.153	.395	1.82	.155
8	.442	2.01	.172	.446	2.04	.174	.452	2.08	.178
9	.497	2.26	.193	.502	2.29	.196	.508	2.34	.200
10	.553	2.51	.215	.558	2.55	.218	.565	2.60	.222
	4.5			4.6			4.7		
1	.057	.26	.023	.058	.27	.023	.058	.27	.023
2	.114	.53	.045	.116	.54	.046	.117	.54	.047
3	.172	.79	.068	.174	.80	.069	.175	.81	.070
4	.229	1.06	.090	.232	1.07	.092	.234	1.09	.093
5	.286	1.32	.113	.289	1.34	.115	.292	1.36	.116
6	.343	1.58	.136	.347	1.61	.138	.350	1.63	.140
7	.400	1.85	.158	.405	1.88	.161	.409	1.90	.163
8	.458	2.11	.181	.463	2.14	.184	.467	2.17	.186
9	.515	2.38	.203	.521	2.41	.207	.526	2.45	.210
10	.572	2.64	.226	.579	2.68	.230	.584	2.72	.233
	4.8			4.9			5.0		
1	.059	.28	.024	.060	.28	.024	.060	.28	.024
2	.118	.55	.047	.119	.56	.048	.121	.57	.049
3	.177	.83	.071	.179	.84	.072	.181	.85	.073
4	.236	1.11	.094	.239	1.12	.096	.242	1.14	.097
5	.295	1.38	.118	.298	1.40	.120	.302	1.42	.121
6	.355	1.66	.142	.358	1.68	.144	.362	1.70	.146
7	.414	1.93	.165	.418	1.96	.168	.423	1.99	.170
8	.473	2.21	.189	.478	2.24	.192	.483	2.27	.194
9	.532	2.49	.212	.537	2.52	.216	.544	2.56	.219
10	.591	2.76	.236	.597	2.80	.240	.604	2.84	.243
	5.1			5.2			5.3		
1	.061	.29	.025	.062	.29	.025	.062	.29	.025
2	.122	.57	.049	.124	.58	.050	.125	.59	.051
3	.183	.86	.074	.185	.87	.075	.187	.88	.076
4	.244	1.15	.099	.247	1.17	.100	.250	1.18	.101
5	.305	1.44	.123	.309	1.46	.125	.312	1.47	.126
6	.367	1.73	.148	.371	1.75	.150	.375	1.77	.152
7	.428	2.01	.173	.433	2.04	.175	.437	2.06	.177
8	.489	2.30	.198	.494	2.33	.200	.500	2.36	.202
9	.550	2.59	.222	.556	2.62	.225	.562	2.65	.228
10	.611	2.88	.247	.618	2.91	.250	.625	2.95	.253

TABLE II. FEEDING STANDARD—*Continued*

Lbs. of Milk	% FAT IN MILK 5.4			% FAT IN MILK 5.5			% FAT IN MILK 5.6		
	Pro.	C-H.	Fat	Pro.	C-H.	Fat	Pro.	C-H.	Fat
1	.063	.30	.026	.064	.30	.026	.064	.31	.026
2	.126	.60	.051	.128	.60	.052	.129	.61	.053
3	.190	.90	.077	.192	.91	.078	.193	.92	.079
4	.253	1.20	.102	.256	1.21	.104	.258	1.23	.105
5	.316	1.49	.128	.320	1.51	.129	.322	1.53	.131
6	.379	1.79	.154	.383	1.81	.155	.386	1.84	.158
7	.442	2.09	.179	.447	2.12	.181	.451	2.15	.184
8	.506	2.39	.205	.511	2.42	.207	.515	2.45	.210
9	.569	2.69	.230	.575	2.72	.233	.580	2.76	.237
10	.632	2.99	.256	.639	3.02	.259	.644	3.07	.263
	5.7			5.8			5.9		
1	.065	.31	.027	.066	.31	.027	.066	.32	.027
2	.130	.62	.053	.131	.63	.054	.133	.64	.055
3	.195	.93	.080	.197	.94	.081	.199	.95	.082
4	.260	1.24	.106	.262	1.26	.108	.265	1.27	.109
5	.325	1.55	.133	.328	1.57	.134	.331	1.59	.136
6	.391	1.86	.160	.394	1.89	.161	.398	1.91	.164
7	.456	2.17	.186	.459	2 20	.188	.464	2.23	.191
8	.521	2.48	.213	.525	2.51	215	.530	2.54	.218
9	.586	2.79	.239	.590	2.83	.242	.597	2.86	.246
10	.651	3.10	.266	.656	3.14	.269	.663	3.18	.273
	6.0			6.1			6.2		
1	.067	.32	.028	.068	.33	.028	.069	.33	.028
2	.134	.64	.055	.136	.65	.056	.138	.66	.057
3	.200	.97	.083	.204	.98	.084	.207	.99	.085
4	.267	1.29	.110	.272	1.30	.112	.276	1.32	.113
5	.334	1.61	.138	.339	1.63	.139	.344	1.65	.141
6	.401	1.93	.166	.407	1.96	.167	.413	1.98	.170
7	.468	2.25	.193	.475	2.28	.195	.482	2.31	.198
8	.534	2.58	.221	.543	2.61	.223	.551	2.64	.226
9	.601	2.90	.248	.611	2.93	.251	.620	2.97	.255
10	.668	3.22	.276	.679	3.26	.279	.689	3.30	.283
	6.3			6.4			6.5		
1	.070	.33	.029	.071	.34	.029	.072	.34	.029
2	.140	.67	.057	.142	.67	.058	.144	.68	.059
3	.210	1.00	.086	.213	1.01	.087	.216	1.02	.088
4	.280	1.34	.114	.284	1.35	.116	.288	1.37	.117
5	.350	1.67	.143	.355	1.69	.144	.360	1.71	.146
6	.420	2.00	.172	.426	2.03	.173	.433	2.05	.176
7	.490	2.34	.200	.497	2.36	.202	.505	2.39	.205
8	.560	2.67	.229	.568	2.70	.231	.577	2.73	.234
9	.630	3.00	.257	.639	3.04	.260	.649	3.07	.264
10	.700	3.34	.286	.710	3.38	.289	.721	3.42	.293

If then a cow weighs 1200 pounds, she would not be given 24 pounds of hay, but 12 pounds of hay and 36 pounds (3×12) of silage. When either silage or hay is abundant it may be fed in quantity proportionally greater and the other proportionally less than that mentioned. This is only a helpful rule, not a law.

The amount of grain a cow should receive will depend largely on the amount and quality of the milk produced. Most commonly one pound grain for every three pounds of milk will suffice, but this must be increased to one to two and a half or even one to two where the cow is yielding either a large flow of ordinary milk or a moderate amount of very rich milk. While if a cow is yielding only thirty pounds of 3.6 per cent milk, a grain and milk ratio of one to three would be ample. As much as one to two and a quarter would be desirable if sixty pounds of 3.6 per cent milk or thirty pounds of 5.5 per cent milk were being produced.

The digestible nutrients required in the production of milk and the maintenance of the cow's body are all found in the various feeding stuffs, but in no two of them are the proportions of these ingredients the same and in few, if in any, is the proportion the same as that needed by the cow for either maintenance or for milk formation. To emphasize this point and to present the matter in the form most usable, Minnesota Bulletin 130 is quoted as Appendix Table III.

The adjustment of the amount of the three nutrients fed to the needs of the cow so that she shall be fully nourished and yet to prevent the waste of any appreciable amount of any one of the nutrients is called "balancing the ration." The truly balanced ration is the most economical ration so far as the amount of feed is concerned and usually also is the economical ration in respect to cost.

Example: Let us suppose a cow weighs 1150 pounds, and is giving daily 26 pounds of milk testing 4.2 per cent fat, what is the amount of nutrients required?

By reference to Table III we see that a cow weighing 1150 pounds requires 0.805 pound protein, 8.05 pounds carbohydrates and 0.11 pound fat daily for mere bodily upkeep. By turning

to Table II, under the section headed "Percentage of fat in milk 4.2," we may easily calculate the amount of each nutrient by taking the amount indicated for 2 pounds of milk and multiplying by 10 and then adding in the amount needed for 6 pounds of milk. Thus we find that for the formation of 26 pounds of 4.2 per cent milk there are required 1.44 pounds of digestible protein, 6.5 pounds digestible carbohydrates and 0.56 pound digestible fat. Adding the two amounts we have:

	Protein	Carbohydrates	Fat
For maintenance	.805	8.05	.11
For 26 pounds 4.2 per cent milk..	1.44	6.50	.56
Total nutrients required	2.245	14.55	.67

From the above we see that the cow assumed must be provided with $2\frac{1}{4}$ pounds protein, $14\frac{1}{2}$ pounds carbohydrates and more than $\frac{1}{2}$ pound fat per day or she will either decrease in milk flow or lose weight, or do both.

To supply the nutriment required suppose we feed:

	Lbs.	Protein	Carbohydrates	Fat
Timothy hay	12	.236	5.21	.168
Corn silage	36	.345	5.15	.252
Corn	5	.395	3.33	.215
Oats	4	.428	2.01	.152
Nutrients provided		1.404	15.70	.787
Nutrients required		2.245	14.55	.67

It will be noted from the above example that, although the regulation amounts of hay, silage and grain have been fed, and that carbohydrates and fat amounts are well provided, protein is 0.84 pound short. This ration is balanced in respect to roughage to cow and grain to milk, but far from it in the more vital part, digestible nutrients, especially protein. Reference to table of analysis shows that cottonseed meal, linseed oil meal, gluten feed and bran are richer in protein than corn or oats. To correct the balance of nutrients and to keep the number of pounds the same, suppose we try the following:

	Lbs.	Protein	Carbohydrates	Fat
Timothy hay	12	.236	5.21	.168
Corn silage	36	.345	5.15	.252
Corn	4	.316	2.67	.172
Oats	3	.321	1.51	.114
Cottonseed meal	2	.752	.43	.192
Nutrients provided		1.970	14.97	.898
Nutrients required		2.245	14.55	.67

In this the requirements are more nearly approached, but the shortage in protein is still too great.

If we shift the grain slightly to contain 3 pounds corn, 3 pounds oats and 3 pounds cottonseed meal we have:

	Lbs.	Protein	Carbohydrates	Fat
Timothy hay	12	.236	5.21	.168
Corn silage	36	.345	5.15	.252
Corn	3	.237	2.01	.129
Oats	3	.321	1.51	.114
Cottonseed meal	3	1.128	.64	.288
Nutrients provided		2.267	14.52	.952
Nutrients required		2.245	14.55	.67

In this case all three of the balances have been met very satisfactorily. It will be noted that the balance of the nutrients is almost perfect. No more feed is consumed in this case, but more milk would be produced and a better physical condition of the cow maintained.

A very material amount of the balancing may often be effected by means of the roughage, by the use of alfalfa or clover hay. Thus we may feed a ration as follows:

	Lbs.	Protein	Carbohydrates	Fat
Red clover hay	12	.853	4.54	.216
Corn silage	36	.345	5.15	.252
Corn	5	.395	3.33	.215
Oats	4	.428	2.01	.152
Nutrients provided		2.020	15.03	.835
Nutrients required		2.245	14.55	.67

In this ration the addition of clover has nearly balanced it. It is, however, ¼ pound short in protein, and ½ pound over in carbohydrates.

In the past, wheat bran has been fed largely for milk production, but while a little is good for the stock more nutriment can usually be obtained for the money by purchasing, instead, some of the grains richer in protein and more digestible. Suppose we try:

	Lbs.	Protein	Carbohydrates	Fat
Clover hay	12	.852	4.54	.216
Corn silage	36	.345	5.15	.252
Corn	4	.316	2.67	.172
Oats	4	.428	2.01	.152
Linseed oil meal	1	.302	.32	.069
Nutrients provided		2.243	14.69	.861
Nutrients required		2.245	14.55	.67

It will be noted that the simple replacement of 1 pound corn with 1 of linseed meal brought the protein up in amount to the point of requirement and that no more total feed was given by the change. This last ration would be a very good one indeed for a 1150-pound cow yielding 26 pounds of milk testing 4.2 per cent fat, daily, and has the advantage over the other balanced ration, both in physiological effect on the cow and of having been produced more largely on the farm, a less amount having been purchased.

Combinations almost without number might be made, but the foregoing will sufficiently illustrate the necessity and the method of ration balancing.

It is not necessary nor advisable that each grain be weighed out separately for each cow. Such would entail altogether too much work and too much disturbance of the cows as well. It is not even necessary to make up a separate mixture for each cow.

A good mixture made of three or more grains may be made up to serve as a complement to the hay fed, and from this grain all the cows in any herd may be fed very accurately by increasing or decreasing the amount of grain and hay given.

A General Rule.—Except when a very large amount of milk or a very rich milk in quite liberal quantity is to be provided for the following general rule will provide an approximately balanced ration. The rule is: " Feed 2 pounds of hay, or 1 pound of hay and 3 pounds of silage, or 1 pound of hay and 1½ of fodder per hundredweight of cow. Then make up a mixture of three or more grains in such proportion as to contain about 16 per cent digestible protein if timothy or wild hay is to be fed, or about 13 per cent digestible protein if clover-timothy mixture hay is to be fed, or about 11 per cent digestible protein if clover hay is to be fed, or about 9 per cent of digestible protein if alfalfa hay is to be fed; and then feed of the grain mixture 1 pound for every 2½ to 3 pounds of milk, if Jersey or Guernsey cows, or 1 pound to 3 pounds of milk if Shorthorn grade, or 1 pound to 3 or 3½ pounds if Holstein."

As an example, suppose grade Shorthorns or Shorthorn-Holstein cows are to be fed and the hay at hand is a mixture of wild grasses and timothy. The hay and silage or hay and fodder would then be fed as already mentioned and would approximately sustain the animal so far as maintenance requirements are concerned. To provide such a herd with grain we may start with corn, oats, or barley and one or two purchased high protein feeds—say bran and cottonseed meal. The mixture to contain between 15 and 16 per cent digestible protein would have to be made about as follows:

	Lbs.	Protein	Carbohydrates	Fat
Corn	4	.316	2.67	.162
Oats	2	.214	1.01	.076
Bran	1½	.178	.63	.037
Cottonseed meal	2½	.840	.54	.240
	10	1.548	4.85	.525

Expressed in terms of per cent the composition of this mixture would be, protein 15.48 per cent, carbohydrates 48.5 per cent and fat 5.25 per cent.

In this the protein is quite up to the amount usually needed

to balance the nutrients in a cow's ration, which has been based on non-proteinous roughage.

In case red clover or alsike clover hay is available to feed with the silage or corn fodder, a less amount of protein will need be purchased because so largely furnished in the leguminous hay. A grain supplement for such would be made up as follows:

	Lbs.	Protein	Carbohydrates	Fat
Corn	6	.474	4.00	.258
Oats	2½	.267	1.26	.094
Linseed oil meal	1½	.453	.48	.103
	10	1.194	5.74	.455

In the above grain mixture it will be noted that only 15 per cent of the total amount of grain is purchased, all the rest is home grown and that the mixture has a percentage composition of protein 11.94, carbohydrates 57.4 and fat 4.55. This mixture will form a very good adjunct to the clover hay fed. There should be no hesitancy, however, in buying high protein grain feeds, since the purchase of such high protein feed may well be considered a double purchase, in that protein is first obtained for the cow's ration and that, following, the manure is made richer in nitrogen for the fertilization of the fields.

A single caution in the use of corn meal is that it should not be fed to a milch cow in amounts greater than about one-half pound per hundredweight of cow per day. A 1200-pound cow may safely be allowed to consume 6 pounds of corn meal per day, an 800-pound cow 4 pounds. If used more freely there is danger of a fatty deposit in the os resulting in sterility. It is also inadvisable to feed cottonseed meal in quantities greater than 3 pounds a day to a cow as a steady ration.

Feed During Heavy Yield.—In all the breeds having the most pronounced dairy type and temperament, there are cows which, when fresh, will yield considerably more milk than can be supported by the amount of feed that the cow can possibly digest and assimilate. All of the substances contained in that amount of milk given in excess of that supplied directly by the daily ration, is obtained from the cow's own body, by a process of absorption. It is natural for cows to flesh up while carrying

the young, and to "milk down" after calving. This fact now is made use of in the making of large milk records.

The question naturally arises, "What should be the nature of the ration fed during this period of losing weight? Should it be a balanced ration to the limit of the cow's ability to eat feed, and thereby force her to extract from her tissue a balanced ration for the remainder of the milk, or should the ration contain practically enough protein to sustain the full flow and thereby permit the cow's vital tissue to remain unimpaired while forcing her to use up her body fat only to provide the deficiency?"

The question has never been closely studied experimentally, but the practice of the men who are now making the large records have very generally adopted the latter method.

An abundance of protein in an easily digested and palatable form stimulates milk production and, what is probably of equal importance, leaves the vital organs and tissues of the cow in good repair after the yield has declined to a point where the cow can sustain the flow by daily consumption of feed.

An example to illustrate: Let us assume a 1400-pound Holstein-Friesian cow in good condition. The matter may be illustrated by figure 76. Let O indicate time of calving; the vertical line amount in pounds and the horizontal line time in weeks; the solid curved line the milk amount and the dotted line the feed amount.

A week or more before the cow is due to calve the heavy grain should be withheld from the cow, she being fed on succulent roughage such as silage and roots with a little hay and just prior to parturition all feed should be withheld, but water provided in abundance and often.

After calving she should not be crowded with feed to force the milk, but rather the cow should be allowed to set the pace in flow while the feed is carefully raised in amount, following, as it were, the lead of the milk.

If in our example (Fig. 76) the cow at the end of three weeks reached a flow of 90 pounds of 4.0 per cent milk, A-C, and is able to consume feed for the support of only 65 pounds of milk, A-B, she will have to make up the deficiency, B-C, 25 pounds,

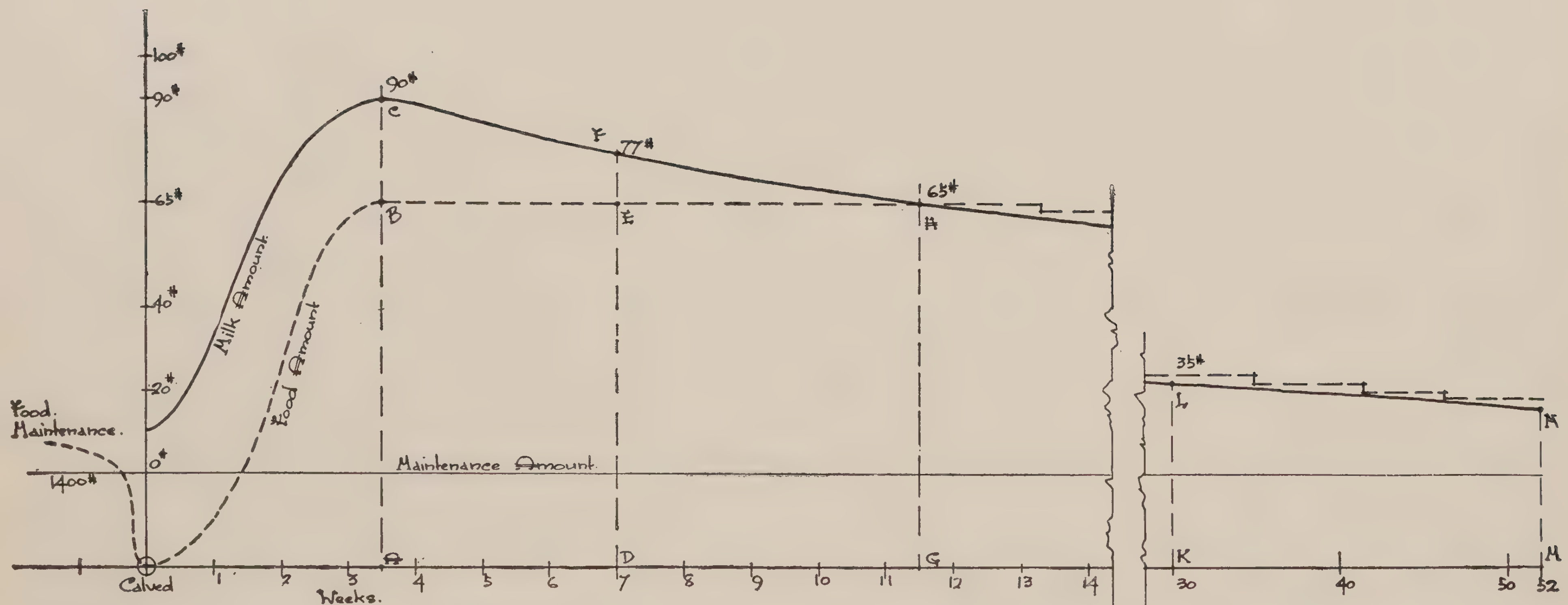

FIG. 76.—Illustrating relation between amount of feed consumed and amount of milk produced, and the fact that at certain times cows absorb their own tissue and convert it into milk.

from her own body. Up to this point and continuing, the feed supplied should contain liberal quantities of protein, enough to meet the protein requirement, if possible. The nutritive ratio of the total ration at A B C would be about 1: 5.0, at D E F, 1: 5.5 and at G H I, 1: 6.0.

As the milk flow naturally declines the proportion of protein to carbohydrates should widen to reach a balanced form at as early a period as possible. Care should be taken not to overfeed in protein, as it is liable to bring on a rheumatic condition, but so long as all the protein feed is needed and the whole ration kept as cooling in nature as possible there is little or no danger of "burning out."

Later in the lactation period when the milk-line falls, the value of about one pound of grain below the feed-line, the grain should be cut down to agree, yet to remain a little above, to support the flow instead of dragging it downwards, as would be the case if the feed-line fell below the milk-line.

The competent herdsman will study carefully each cow that he may provide her not simply with feed nutrients, but also in the form most pleasing to the particular cow. Some cows dislike cottonseed meal, but will take linseed oil meal with zest; some prefer less silage and more hay; some crave wheat bran, or some form of sugar feed or roots. Each cow has a favorite without which she will not take the maximum of feed. They should be studied separately and humored.

Roots such as mangles and rutabagas have been fed for many years in various parts of the world, but are only recently coming to form a part of the cow's ration systematically, and in the place of some grain rather than as a competitor of corn silage. A field, planted to corn where corn grows even reasonably well, will produce more feed per acre, and per dollar cost of growing, than if planted to roots, but either mangles or rutabagas compete successfully with either oats or barley as milk producers. Moreover, the tender succulent condition of the feed in roots renders them more easily masticated and digested than hay, in fact equal to good grain. Roots and potatoes may then be systematically substituted for a part of the grain ration called for by any cow giving milk. In practice one-half the

grain may be withheld and roots substituted at the rate of 11 pounds of mangles, 9 pounds of rutabagas or 5 pounds of potatoes to replace 1 pound of grain.

If a cow is yielding 40 pounds of 3.8 per cent milk she may be fed hay and silage according to her weight. Then instead of feeding ($40 \div 3 = 13$) 13 pounds of grain, 6½ pounds of grain may be fed and 70 pounds of mangles or 60 pounds of rutabagas, or 33 pounds of potatoes, substituted in place of the remaining grain.

Order of Feeding.—It is natural for all animals to be more or less nervous or even irritable when hungry. It is at such times that the milkers are most likely to get into trouble with the cows. It is desirable, therefore, to feed the cow her grain first and to milk while she is eating. Hay should be fed after milking because so often dusty, and silage and roots after milking because of their odor.

Cows need be fed but twice a day, the total amount of hay, silage and grain being divided equally between the morning and evening meals.

The balancing of the nutrients of a cow's ration is not now a difficult task and it is no longer a question that cows consistently fed approximately balanced rations will remain in better physical condition, drop stronger calves and yield more milk at less cost than cows not so fed.

The kindly and regular care and comfort given the cows has nearly, if not quite, as much to do with profitable returns as has the balancing of the ration. The cow has been said to be "a profitable recipient of affection."

A silo is an immense barrel into which green feed, like corn, is cut to be used as feed for livestock.

The advantage of the silo in American agriculture may be briefly summarized as follows:

1. Silage keeps young stock thrifty and growing better than dry fodder.
2. It produces beef more cheaply than dry hay.
3. It enables cows to produce milk and butter more economically.

4. It brings them out in the spring in such condition that they shed their winter coats and commence gaining at once.

5. The silo prevents the waste of the corn stalks which contain from 40 to 60 per cent of the total feed value of the field of corn.

6. And, therefore, a larger number of animals may be kept on a given amount of land.

7. The silo furnishes the most economical method of preserving feed for the hot, dry period in summer when pasture is short.

8. It is usually preferable to a full soiling system for summer feeding.

No dairy or general livestock farm is properly equipped for economical production until a silo of some sort is provided (Figs. 77, 78 and 79).

The kind of a silo is not essential, but rather the three points, namely:

First, its height should be about twice as great as its diameter to insure sufficient pressure to expel the air from the cut corn and thus reduce the spoiling.

Second, it must be practically air-tight about the sides and bottom to prevent admission of air which will cause or bring about rotting of the silage.

Third, it must be made strong enough to withstand a heavy outward pressure.

The wooden stave silo has the advantage of producing a very sweet silage if the corn is at all right, but has also the disadvantage of drying out quickly when empty, with liability of collapsing.

The cement block or monolith silo probably does not produce quite so sweet a flavored silage as a wooden silo, but it is more permanent if well reinforced. And, so long as the cows do not object to the slightly modified flavor, why should man?

The acid from corn put up too green has a perceptible effect on cement walls and foundations, but the amount generated in silage from mature corn is negligible in effect.

Effect of Silage on Milk.—Milk produced by cows fed even heavily and continuously on mature corn silage will not be less tasty or valuable than any other and will be better for children

Fig. 77.

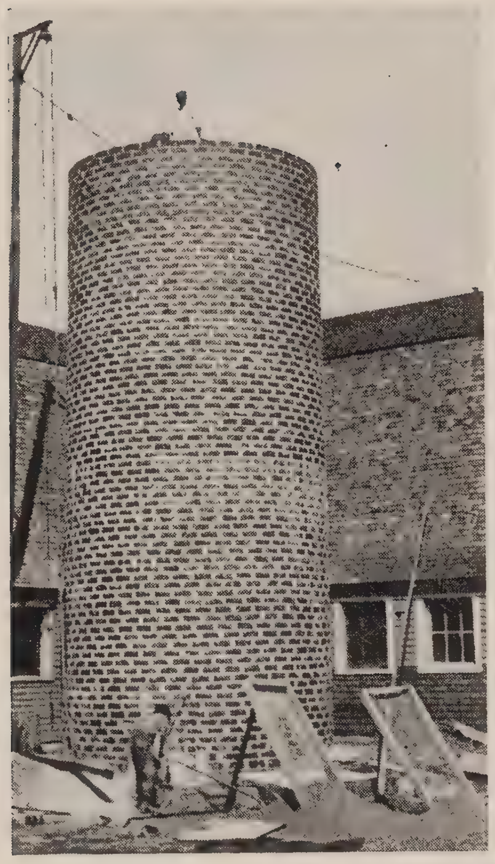

Fig. 78.

Fig. 79.

Fig. 77.—Silo, clay block, hollow wall, erected at the Agricultural School Farm, Crookston, Minn.

Fig. 78.—This home-made, plaster-lined silo cost little and gave perfect satisfaction. (Woodland Dairy Farm.)

Fig. 79.—Octagonal barn being built around a silo made by nailing 2 x 4's solidly together flatwise in an eight-sided form. (Owned by J. H. Nixon, Nevis, Minn.)

and infants for the reason that the cows are in better physical condition. If, however, the feed is excessively sour from being put into the silo too green, the milk will not have the rich, full aroma that it ordinarily possesses. Such silage should be fed in lessened amounts with more hay.

Cows' teeth will not be affected by silage if it has been made from even reasonably mature corn and fed in conjunction with dry hay or corn fodder.

Weed seeds present in hay or grain fed to cows are passed unchanged, unless it be that they grow a little better after the treatment,[3] but seeds of all kinds except mature clover and alfalfa are practically all destroyed by being put into a silo.[4]

QUESTIONS

1. At what season do cows naturally yield most milk?
2. At that season what are the conditions as to (a) feed supply, (b) succulence of feed, (c) temperature, (d) proportion nutrients in the feed?
3. Why should cows be made to freshen in the fall, as a general rule?
4. Illustrate on the board how one cow may by consuming 25 per cent more feed have 100 per cent more for milk formation.
5. How may common hay be made more palatable?
6. What is meant by succulence?
7. What is a feed nutrient?
8. What is a ration?
9. What is a balanced ration?
10. What is meant by a maintenance ration?
11. As the fat per cent increases in milk how do the protein and carbohydrates vary?
12. What is the particular value or use of protein in feed? Of carbohydrates? Of fat?
13. Is it necessary to feed each cow a separate grain mixture?
14. How may every cow be fed what she needs from one grain mixture?
15. Give the general rule in feeding.
16. Discuss the use of roots in the place of grain.
17. What is the preferable order of feeding?
18. What are the three essentials of a good silo?
19. What are the advantages of a silo?
20. Under what conditions may silage affect the milk yielded by the cows?

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[3] Beach, C. L. Vermont Bul. No. 138; Oswald, W. L. Minn. work in progress.

[4] Washburn, R. M. Vermont Bul. No. 170.

CHAPTER XXIV

CALF RAISING

NATURE'S system in the matter of calf raising is apparently that the calf should be born in the spring time; should suckle its dam until six or eight months old; and during this time gradually work on to grass and dry feed. This, however, is entirely too extravagant for the present conditions of life in the dairy sections of the country. By this system the owner of the cow realizes an income on his investment equal only to the value of the calf at the end of the year.

Furthermore, cows as now developed for dairying will produce from two to ten times as much milk as needed by the calf and the value of butter fat on the market is too high to warrant its being fed for any considerable length of time to calves.

Under the cheap land and scarce labor conditions, where beef husbandry is preëminently the form of livestock found most profitable, the system of raising the calves upon their dams is unquestionably correct. Under opposite conditions, namely, high-priced land and more abundant labor, it is unprofitable indeed to permit the calf to consume whole milk for a period longer than is really necessary to get it well started. The general livestock and grain farms of the country will therefore present problems varying all the way from one extreme to the other.

Veal calves are often produced in order to obviate the necessity of milking for a period of six to eight weeks during the growth of the calf. While this system has the advantages of slightly lessening the labor on the farm, the disadvantages are apparent when the calf is removed. Not alone has the calf been consuming 30-cent butter fat and converting it into 10-cent veal, but there is in nearly all cases a decided falling off in the amount of milk which the mother will give after the removal of the calf.

Cows care very little indeed for their calves at the time of birth, but their affection increases rapidly as they are permitted to clean them off and especially when the little things suckle a few

times. So intense does the mother love become during the period of veal making, that at the end of six or eight weeks, when the calf is finally removed, the mother not infrequently will hunt for her calf, bawl about and hold up her milk until going nearly or quite dry. If the cow is later to be milked it will be found a decided detriment to allow the calf so long a period with its mother.

Occasionally a cow that is hard to milk or otherwise disagreeable, may be turned over to calves and suckled by them, one after another, and thus be made to return good value during a period of stress.

The Importance of Raising Calves.—Many times the question has been raised whether it were preferable for individual dairy farmers to raise their own calves or to buy "springers" when fresh cows are needed. Obviously someone must raise calves if the number of cows is to be maintained. The economy of the practice of dairymen living near cities, producing milk for market use, in purchasing cows as needed and making no attempts at raising young stock will not be questioned. Farmers, on the other hand, who keep a limited number of cows and who have large quantities of hay and corn fodder for consumption should by all means raise their own young stock rather than to trust to the market. It is common observation, too, that the specialized dairymen near the cities are better judges of cows than are most farmers, and that where possible it is desirable that the best of the city dairy cows be bred and that the young stock be raised on the farm farther back from the cities. Certain it is that if improvement is to be made in the class of cows kept, calves must be reared from the best individual cows.

Fall calves have the advantage over those born in the spring. During the first few weeks of the calf's life he lives almost wholly upon milk, whether there be blue grass or snowdrifts just outside the barn. As he matures, more feed, especially grain, is consumed. All this can take place in the winter as well as in the summer. The October or November calf will, by May, be old enough to make use of pasture and should be given a moderate amount of it. The autumn calf then reaches its

first period of dry feed without milk when nearly or quite a year old. The spring-dropped calf, on the other hand, consumes its milk during the period of good pasture and at six or eight months of age, when it would normally be weaned from milk, finds itself confronted with winter conditions while still too young to withstand them well. The calf dropped in the fall is usually as large and as valuable at a year old as the spring calf at a year and a half. The farmer finds more time to care for the calf in winter than in summer. From the standpoint of the calf as well as that of the profitableness of the cow, dairy calves should be dropped during the last three months of the year.

Removing the Calf from the Mother.—One mistake often made is in allowing the calf to remain too long with the mother. She becomes attached to it and it becomes accustomed to her, and objects to learning to drink from a pail. Experience teaches that it is best to remove the calf as soon as it has been cleaned off, at any rate not allowing it to suckle more than once. When the cow is out of the box stall for water the calf should be removed without attracting her attention, and placed in dry comfortable quarters, out of hearing of its mother, if possible. When the cow returns to the stall and notices the absence of her baby the wise dairyman will be on hand with a palatable mass of bran mash or steamed oats, and ready to be substituted in the affections of the cow for the little one that has been lost. This transfer of affection is easily accomplished at that time.

Allow the Calf to Become Hungry.—If the calf has been permitted to suckle once it will not usually be sufficiently hungry at the end of twelve hours to learn easily how to drink. No harm whatever will come to it if twenty-four hours elapse before its first meal after removal from the mother. When keenly hungry it will learn very readily. From one to three lessons only are then needed to teach the average calf the art of drinking from the pail.

First Feeding.—The first milk drunk by the calf from the pail should be a portion of its own mother's milk, sweet, warm, and clean, and not more than a quart in quantity. In teaching the calf to drink the feeder should remember that the calf is a

baby and cannot be anything else until given time to grow. The ridiculous struggles occasionally pictured in teaching the calf to drink exhibit only ignorance on the part of the man. By first backing the little fellow into a corner and then locking his neck between the legs of the feeder, as in a stanchion (Fig. 80), the pail may be held in the left hand; the tips of the fingers on the right hand moistened with milk and inserted into the calf's mouth. At the taste of the milk the calf will commence to suck. Then slowly the head may be drawn downward until the

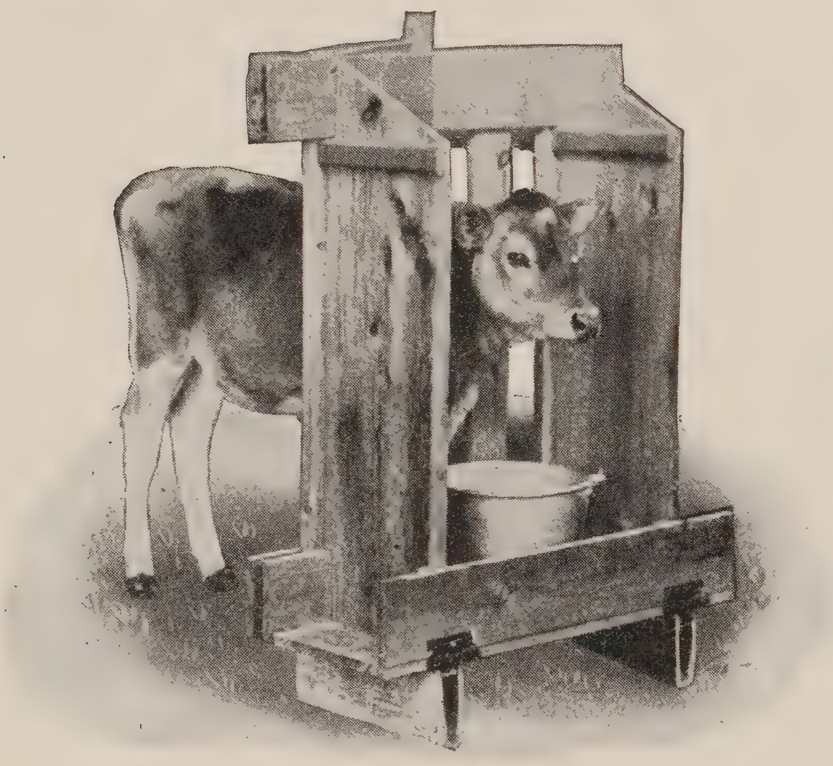


FIG. 80.—Inexpensive calf stanchion. (Courtesy Wisconsin Station.)

milk is reached. The calf then sucks the fingers, drawing the milk between them. When well started the fingers should be slowly withdrawn while the right thumb is held merely on the top of the nose. To be sure, the calf's head may fly up at any instant when the process will need to be repeated. An intelligent calf, keenly hungry, will occasionally learn to drink with the first lesson and usually with the second. Almost never will the calf have to be shown more than three times before it will proceed to drink from the pail unaided.

Later Feeding.—During the period of about three days, when the cow is yielding colostrum milk, portions of such should be fed to the calf, the quantity naturally varying with the size and strength of the calf. No hard and fast rule can be laid down in this any more than in any other phase of dealing with live animals. It is a good rule to start out giving about one quart of milk at a feeding. During the first week it is often wise to feed the calf three times a day, especially if it is weakly and un-

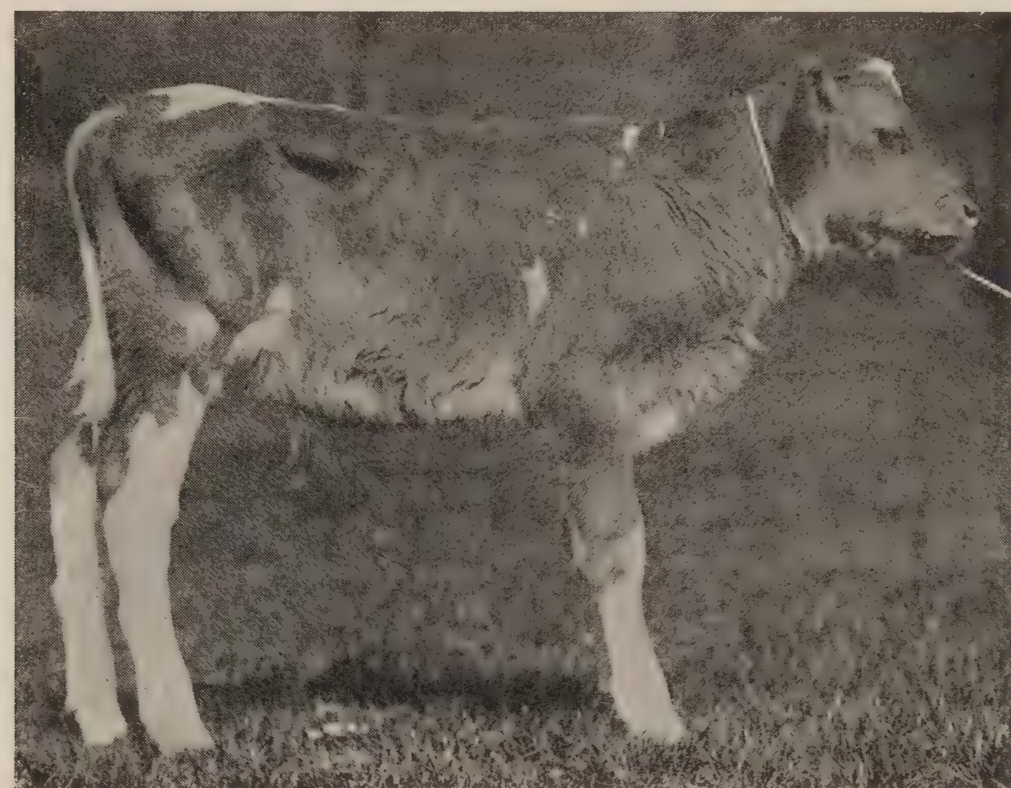


Fig. 81.—Tender but healthy. Needs only good care and feed.

able to consume a large quantity. After a week or ten days two feeds a day will be found quite as satisfactory as three.

The milk fed must be sweet, warm and from a clean pail, and not too great in quantity, otherwise digestive disturbances are liable to occur, resulting in diarrhea, loss of strength and if not checked soon, the calf may either die outright, or be stunted so that many months will be required for his recovery.

The quantity of milk which should be given the calf will after three or four days be not far from one pound per day for

every eight or ten pounds that the calf weighs. A calf weighing sixty pounds then would receive six to eight pounds of milk per twenty-four hours, divided into two or three feedings. For this purpose measuring is sufficiently accurate, considering a quart to weigh two pounds. The first milk given should be whole milk, first from its own mother and later from the herd, provided, however, such milk does not carry more than $3\frac{1}{2}$ to 4 per cent fat. Rich milk is not good for calves. It is liable to bring on diarrhea. This is particularly true of the thin, tender little calves often born in Jersey and Guernsey herds. Where the herd milk is of Jersey or Guernsey cows it is preferable that a little sweet skim milk should be added to the whole milk, even from the start, sufficient to bring the fat content down to at least 4 per cent, and preferably down to 3 per cent. On such milk the calf then may be fed, in quantity according to its weight, for one to three weeks, depending upon its strength. At the end of this period it is usually found possible to lessen the amount of whole milk used, and to increase the amount of skim milk used, keeping the total of the two the same, however, and thus withdrawing the whole milk entirely from the ration. A period of at least a week should be used in making the transition. A common error at this point is to feel that since skim milk is not as rich as whole milk a larger quantity should therefore be given. This is emphatically not true. The substance withheld in skim milk feeding is fat and this cannot be replaced by feeding more of the skim milk which does not contain fat. The quantity of skim milk fed per day should not be greater than would readily be consumed if the fat had been left in it, but the deficiency should be made up by substituting grain. Thus it is possible to make ground corn, and later shelled corn, worth $1\frac{1}{4}$ cents a pound, practically take the place of butter worth 30 to 40 cents a pound. The average calf should gain from one to one and one-half pounds per day (Figs. 82 and 83).

The grain fed to a young calf should consist of a fine soft meal, such as shorts, but when four weeks old the grain should have the same ingredients which would ordinarily be fed to dairy cows. A portion of the cow's grain mixture, if rightly

made, will suffice for the calves. It should consist of corn, oats or barley, middlings or fine bran, and oil meal. Calves will learn, even at two weeks of age, to nibble of the mixture, and at three weeks will regularly consume considerable quantities. Grain should thereafter be fed in quantities sufficient to keep the young animals growing thriftily. At no other

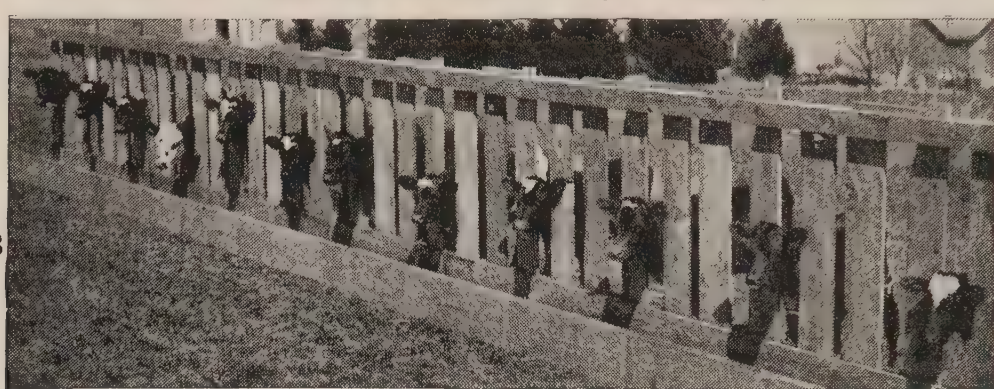


FIG. 82.—Stanchions for calves to prevent the strong from stealing the food of the weaker and to prevent all from sucking one another.

FIG. 83.—A group of skim-milk calves. Note thrifty condition. (Courtesy of G. W. Gehrand.)

time in the animal's life will so small a quantity of grain be of such great benefit.

Hay for Calves.—It is surprising to note how young calves will begin regularly to eat quantities of hay, provided it is tender and otherwise palatable. At three weeks of age they begin to eat a few straws at a time and increase until liberal quantities are regularly consumed. It is highly to be recommended also that calves intended for dairy purpose be encour-

aged to eat hay as young and as freely as possible. By consuming hay thus freely less grain is necessary for their raising, and they are likewise to a considerable extent developed while young in their capacity to handle roughage. The hay best adapted to the use of young calves is second cut clover, or, if this is not obtainable, then something approaching that as nearly as possible in character. Second cut meadow hay (rowen) is very good indeed, because so tender and easily masticated.

By rationally combining skim milk, ordinary grains and tender hay, calves are regularly raised on the best dairy farms at little expense and made to be perfect beauties while young and valuable when older.

Order of Feeding.—Warm skim milk, free from excessive foam, is a highly nutritious feed for young animals of all kinds, but it is delicate and easily made unfit if fed in a dirty germ-laden pail, or if fed just after or immediately before the calf has eaten silage. The acidity of the silage seems to sour the milk before it can have time to digest. Calves so fed often stand for some time belching gas and showing signs of distress. A change in the order of feeding to grain, milk, hay and then silage has brought relief and decidedly improved the condition of the calves which had been so fed.

Pasture for calves is of doubtful value. While small amounts of grass will be consumed by the calf born in autumn or winter it should not be required to consume large quantities or to depend very largely upon grass for its sustenance. The heat of an unshaded yard may easily undo the beneficial effects to be secured from the outside run and if the calves are forced to live out of doors during the latter portion of the summer, when the grass is more or less tough and dry, and flies numerous, there will usually be a period of stagnation in growth when no advancement is made. Under such circumstances the calves would be much better off eating their few pounds of hay, a little grain, water, and skim milk if available, in the barn. Calves should gain three-fourths to one and one-half pounds per day when three to eight months old.

Raising Calves Without Milk.—In regions which regularly ship whole milk to cities the question of how to raise the

calves without holding back so large a quantity of milk is a vital one. To raise calves on milk worth $1.75 a hundred pounds makes him a rather expensive animal, while to raise no calves and to trust to the open market to replace the dairy is unsatisfactory from the standpoint of character or efficiency of the animal to be secured and the likelihood of introducing disease.

For many years various concoctions have been tried and a few recommended as substitutes for milk in calf feeding. To make a long story short, the result of the many trials is that calves can be successfully reared upon a very small quantity of milk used in conjunction with an adequate amount of mixed grains, but that milk in some amount is practically essential. It is a settled practice in the milk-selling regions to withhold a small amount of milk for the purpose of supplying cream for the table and skim milk for the calves. A quart of skim milk is then diluted with water and fed, care being taken that the grain supply is ample and adapted to the calf's age.

Calf Meals.—Various compounds of cereals under a variety of names have for many years been advertised, a few for a century or more. Careful trials of the matter have proved that good calves may be raised on a very small amount of whole milk (60 to 90 pounds) and a moderate amount of skim milk (350 to 400 pounds) by the use of a calf meal. A very satisfactory calf meal may be made, according to Lindsey, as follows:

Ingredients of Calf Meal

22	pounds ground oat flakes
10	pounds ground flaxseed meal
5	pounds ground flour middlings
11	pounds finely ground corn meal
1½	pounds prepared blood flour
½	pound salt

Cost, about 3 cents per pound.

To use this meal with success essentially the following method should be followed: The calf should be removed from its mother and taught to drink in the manner already described. At eight to twelve days of age sweet warm skim milk should be added to the calf's mess, a little at a time and taking the place of the same quantity of whole milk. The second day of change a little more skim and a little less whole milk is fed; thus the

change is made to cover a week or ten days. By the time the milk fed is about half and half, skim and whole milk, a few ounces of the calf meal mixture should be stirred into the milk. This can best be done by making up the meal into a paste in cold water and then adding to the milk. The meal is gradually increased as the whole milk is decreased until when the calf is about three weeks old it is living on skim milk and calf meal. This diet of skim milk and meal gruel should continue until the calf is about three months old, when milk may be entirely withheld.

The calf will already have learned to eat tender hay and small amounts of ordinary grain so that by the time the calf is six months old the feeding of the calf meal may be stopped. From this time forward any thrifty calf will do well on tender hay, common grain mixtures and water.

Whey for Calves.—In regions where cheese is largely made the problem of raising calves is one of successfully combining whey with grain in such fashion as to produce thrifty stock. In the process of cheese making practically all of the fat and casein is removed from the milk. The substances remaining are sugar, albumen, a very little casein and a little fat and ash. The total solid content of whey is nearly one-half that of whole milk and about two-thirds that of skim milk. One hundred pounds of whey ordinarily carries from 5½ to 6 pounds of solid feed, while skim milk has only about 9 pounds. The problem of raising calves in cheese districts has been solved in very much the same way as in whole milk shipping regions, namely, the combination of a small amount of milk with a generous amount of calf meals and common grains.

Whey fed clean and sweet is better than water, but if allowed to become contaminated in a dirty whey tank or barrel it may cause scours and be worse than no whey. Whey is worth most when mixed with grains and fed to swine.

Sweet whey combined with a calf meal will sustain a calf at an early age, two to three months, and may be continued until the calf is six or nine months old with profit.

Calf Scours.—The most common form of calf scours is caused by any sort of interference with the process of digestion. In many places the most frequent cause is over-feeding on milk

which is neither sweet nor sour, but in that dangerous half-changed condition. In addition to this many farmers have been guilty of feeding tender young calves out of pails so dirty as to be absolutely unfit to bear feed to any animal. The germs of decomposition growing continually in the crevices, and on the side, are distributed through the fresh milk supply and introduced into the calf, where they continue to grow and cause various sorts of evil conditions. Worse even than this is the practice of pouring the milk into a tub or half barrel in the yard, permitting the calves in the yard to jam their way in and drink at will. The strongest secure too much and the weakest not enough, and all get dirty stuff and suffer.

For many years farmers have had difficulty in raising calves on skim milk as it has been returned from the creamery. This fact has been one of the reasons why the introducing of hand separators has been so rapid and thorough within the past ten years. With the strict enforcement of the law requiring the pasteurization of skim milk to prevent the spreading of tuberculosis it was found that very good calves indeed could be raised on the milk returned from the creamery. A few who have had trying experiences with skim milk from the creamery have settled upon the practice of permitting the milk to become thoroughly sour before feeding it to the calves. Thus, "clabberred" sour milk has been successfully fed to even young calves and to the certain knowledge of the writer produce fine, thrifty stock. This should not be surprising, however, when we remember how many thousand human infants are now being reared upon buttermilk, beginning even at the age of two weeks or less and continuing until six to eight months of age. Certain it is that milk fed to a calf should be either thoroughly sweet or thoroughly sour and in the same condition every time. See Chapter XXII for discussion of treatment of scours.

Blood meal has been found highly beneficial in correcting digestive disturbance in calves. A tablespoonful of blood flour, mixed with a small quantity of milk, fed to a calf with diarrhea acts as a corrective in such disturbances and is a highly nutritious feed as well.

Raw eggs are excellent feed for a young calf which has

started to scour from some fermentation of the milk it has drunk. Eggs do not ferment as does milk because they contain no sugar. While eggs spoil readily enough, the germ of egg decomposition is not the same as those germs that infest the intestines of calves; thus eggs are often a safe substitute for part or all of the milk for a few meals for calves suffering from scours.

Bone meal is found to be a good substance to mix with salt for young cattle. Some feeds are deficient in the bone-forming elements. This possible deficiency can be insured against by the feeding of a very moderate amount of bone meal.

It has been shown experimentally that an addition of ash to the ration of growing animals increases the size and the strength of the bone. An excess over absolute needs does no harm even if continued through the whole growing period.

Water should be available to growing stock at all times or at least be made available at least three times a day.

Young Calves Need Rest.—The size of calf pens need not be greater than 6 $\times$ 8 feet in which not to exceed three calves should be kept. Individual pens only about 4 $\times$ 4 feet in size are preferable for very young calves, especially those of the Jersey and Guernsey breeds. A young calf is an infant and requires much rest. If placed in a pen where there are several older calves he is jostled about until thoroughly fatigued. Young calves doing very poorly under such conditions often pick up rapidly when placed in small individual pens.

The floor of calf pens should be of some water-tight material which will not conduct heat readily. A cement floor is most easily cleaned, yet it is exceedingly hard on the young calf, as it becomes wet so quickly. It may be cold unless very heavily bedded or insulated as described in Chapter XXI. Tender cow-babies should not be compelled to lie where their soft warm stomachs may be chilled. This often causes diarrhea which results in increased cost in raising the calf and produces an animal of less value. If a cement floor is used it should be overlaid with plank, cork-brick or creosoted blocks, or should be insulated the same as that part of the general stable floor upon which the cows must stand and lie.

Good light, and free circulation of air are so desirable in

the calf pen that barns being constructed should take this class of needs well into account and locate the " children's " room on the southeast or southwest corner of the barn.

Sucking.—Practically all calves, if permitted, will, when through drinking their milk, turn and suckle the other calves present. The practice should not be permitted for the good of either calf. Heifer calves thus suckled will in a few months develop the udder abnormally on the side usually massaged by the process. Poorly formed udders in mature cows are occasionally traceable to carelessness in this regard on the part of the manager. Calves frequently, too, form the habit of consuming the urine from a neighbor calf, which practice is very detrimental to both. This is one reason why it is so highly advisable to lock the calves in a stanchion before feeding and compel them to remain there until the impulse to nurse has left them (Fig. 82). Rub bran on the nose after drinking.

Open vs. Sucking Pails for Calves.—The theory is often expounded that calves will do much better if compelled to take more time in the drinking of their milk. To this end various devices resembling cows' udders with a single teat below have been put upon the market. A test of the value of slow versus fast drinking has recently been made with the evidence favoring the slow consumption of the milk. Earlier tests and practice in general do not show sufficient difference in the two methods to warrant the extra cost of the instrument used and the extra labor in keeping it clean. Briefly, then, if the milk is in good condition and fed in proper amounts and in the right order, the rate of consumption of the milk will be found a very minor matter.

Dehorning with Caustic.—Calves at birth have no horns. The organ develops first on the skin as a button, loose from the skull, later attaches to the skull proper. A horn may be killed while still a mere lump in the skin with caustic potash. The hair should be clipped away carefully around the spot to be treated; the skin thoroughly moistened and rubbed soft. A stick of caustic potash may then be touched carefully to water and rubbed into the skin over the embryo horn. Care should be taken that there is not so much water present as to run

down the side of the face. This will burn off the hair and cause sores. When the scab over the horn falls off a second application will usually be found sufficient to entirely prevent the growth of the horn. Dehorning with caustic should be done when the calf is but two to three days old.

Age to Separate Calves.—Well fed Jersey and Guernsey calves have been known to breed at 90 to 100 days of age. Holsteins and Ayrshires reach this stage of development at from 100 to 120 days. Bull calves reach a similar stage of development at four to five months of age. The dairyman of foresight then will separate the sexes before harm occurs.

Condition of Dairy Calves.—While the consumption of milk containing a liberal quantity of fat will cause the calves to become fat enough for good veal at six to eight weeks of age, it is difficult indeed to fatten calves on skim milk and grain. More liberal feeding up to the limit of their ability to consume, results more in a rapid growth than in fattening. Furthermore, for dairy purposes there is no need that the calves be fattened, and there is danger associated with the condition. Calves fed too much grain, especially corn, are in danger of forming the fattening habit, which may detract from their value as dairy cows later, and if continued until the breeding age, the fat condition is very liable indeed to cause sterility, or inability to breed. The consumption of more hay and less grain in the growing heifer tends to produce an efficient dairy worker in after-life, as well as working towards economy in the raising of the animal. Grain should be fed in amount sufficient only to keep the animal in fair flesh and growing continually.

The influence of early feeding on the size of the mature cow has long been suspected. Best experimental evidence has been furnished by the University of Missouri in which it is clearly shown that if a cow is to attain her greatest stature she should be liberally fed while young (Fig. 84). In fact those cows that receive very liberal rations during their early growing period not only reach their growth at an earlier age but attain to a greater size than those which have been more scantily fed during the first two and a half years of their lives. Whether

heavier cows are desirable is another question. The practice of our best breeders now is to crowd the young stock with an abundance of succulent roughage, adding only as much grain as is necessary to keep them in good condition. It is also shown that with strong dairy cows fat laid on in the early months rapidly disappears upon commencement of lactation.

Fig. 84.—A thrifty Holstein heifer, developed by liberal feeding.

This must not be construed as advocating over-fatness in young stock, for such would likely impair their breeding qualities. Dairy young stock does not, however, require being kept so thin in flesh as has been recommended and practiced by many.

The age to breed the dairy heifer will depend somewhat upon the development of the particular heifer in question. If

the individual is well grown and has a tendency to lay on fat she should be bred at an earlier age than one not so well grown and showing less tendency to flesh formation. The well developed Jersey should be bred to drop her first calf when she is not more than twenty-six months of age, and better twenty-four rather than twenty-eight months, while the heifer of retarded growth should be given two or four months more time in which to reach the size established for the breed, or twenty-six to thirty months. The aim should be to put the young animals off the boarder and onto the working list at as early an age as their physical development will permit without doing permanent harm. If bred too young the energies of the heifer are diverted to the development of the fœtus and later to milk yielding, with the result of retarding growth, sometimes amounting to actual stunting.

The development of the dairy bull is not essentially different from that of the dairy heifer except that a little more grain and a little less of the bulky feeds may be fed. Over-fatness, however, is to be avoided as being, first, an unnecessary and expensive condition, and second, endangering the breeding power of the animal. Hay and skim milk may form the major portion of the ration, with grain fed as a conditioner. A large paunch is not desirable on the breeding sire, however, and may be avoided by feeding less roughage and more grain.

Pasture Necessary for Young Stock.—Although the tender calf needs the protection of the stable more than the invigorating effects of pasture, the yearling should certainly be forced to live upon pasture. Not only can young stock of this age make good use of cheap range, but if they are to develop hardihood, good health and vitality, they should be given ample pasture. One disadvantage found in the soiling system of cow feeding is that it does not provide means whereby the growing heifer can get the exercise essential to strength at maturity.

Cost of Raising Calves.—This question has been studied in several states. By Trueman of Connecticut, the cost is fixed at about $66 for a two year old. From records kept for 117 calves in Wisconsin, Bennet and Cooper conclude as follows:

Cost of Raising Dairy Heifers in Wisconsin

	Cost to 1 yr.	Cost to 2 yrs.
Initial cost of calf	$ 7.04	$ 7.04
Feed	24.67	40.83
Labor	4.45	7.81
Interest, insurance, upkeep, etc	6.36	13.73
Gross cost	$43.52	$69.41
Credit for manure	3.00	8.00
Net cost	$39.52	$61.41

The cost on any given farm will vary with the cheapness of pasturage, value of hay on the farm and cost of labor, whether done by a high-priced hired man or by a child in the home.

QUESTIONS

1. Is "nature's way" of raising calves sufficiently economical for present conditions? Why not?
2. Figure the value of the milk consumed by the next veal calf produced on your farm. What costs have you observed?
3. How should calves be raised?
4. Why is a fall calf usually superior to a spring calf?
5. Tell how to steal the calf from its mother.
6. How should the calf be handled during the first 24 hours after removal?
7. Tell how to teach a young calf to drink.
8. Tell how to feed the calf from time of teaching to drink until three months old.
9. How fast should a calf gain in weight from one week to one month? From one month to three months?
10. How young will calves eat hay?
11. In what order should calves be fed?
12. How should pasture be used for calves?
13. How may calves be raised with use of the least possible amount of milk?
14. What is the value of whey for calves?
15. What are the chief causes of scouring in calves?
16. How may calf scours be treated?
17. How and why is bone meal used for young cattle?
18. How may sucking often be stopped?
19. Tell how to dehorn a calf.
20. What influence has liberal feeding while young on size at maturity?
21. At what age should heifer calves of the dairy breeds be bred?
22. Tell how to develop the dairy-bred bull calf.
23. To what class of young stock is pasture essential?
24. About what does it cost to raise a heifer from birth to two years of age?
25. How may the actual cost on any particular farm vary?

PART V

CLEAN MILK PRODUCTION

CHAPTER XXV

CLEAN MILK PRODUCTION AND HANDLING

Since cow's milk is such an exceedingly important item in our present system of living and since the true value of the milk hinges so largely upon its cleanliness, it is highly important that the essentials of clean milk production be understood by milk producers.

The cows should not only be healthy and in good physical condition, but also sufficiently clean to permit of milking without the heavy contamination so often following that process. To this end, the barnyards need be kept sufficiently clean and dry as to enable cows to walk freely without becoming dirty or, in other words, milk should not be permitted to be sold where bad conditions cannot be rectified (Fig. 85). The ordinary drinking ponds found in the cow pastures in so many parts of the country are sources of contamination. The cows wade in to drink, then defile the water until soon the whole is a fertile medium for the growth of many forms of slime and bacteria. The slimy stuff dries on the cows and is chaffed off into the pail at milking time. In dairy cow pastures such drinking ponds should be fenced and provided with a tank out of which water may be got without its becoming polluted.

The milkers have been shown to be another fruitful source of contamination where care is not exercised in keeping the hands clean during milking. The milker's clothing is also an item in this connection. If dusty, contamination is practically sure to follow. The ordinary dirt on the milker's overalls, while not at all desirable, is not necessarily a source of contamination. White suits are nice if kept clean, but expensive. Ordinary blue or khaki overalls may be kept just as sanitary as white ones and show dirt much less. The milking should be done with dry hands. Wet handed milking is a filthy habit and entirely unnecessary.

Milking stools made of metal and so simply constructed that they may be readily washed are of some aid in the production of the highest class milk. Naturally some of the effects of hand washing and udder cleaning will be lost if the milker is compelled to seize a dirty stool just before starting to milk. Though this is a minor item it nevertheless is one of the points to be observed in the process of producing the highest class milk.

The pails used are another factor. The ordinary open top milk pail seems to have been designed to catch all the dirt possible. A pail 12 inches in diameter will have 113 square

FIG. 85.—A well-lighted dairy barn. Note that top sash of windows fall inward to aid in ventilation. Owned by H. P. Hood and Sons, Boston. (Courtesy of James Mfg. Co.)

inches of dirt-catching surface, whereas one with half the opening will have only a quarter as much exposed area. Then again, if this open portion is raised to an angle shown in the accompanying illustration (Fig. 86), a much smaller dirt-catching area will be presented. There are many so-called sanitary milk pails on the market. Many are reasonably good, some are ridiculous. The construction of the pail within is quite as important as the closing of a part of the top. All seams should have been flushed full of solder, making it possible to clean them, or better the pail should be made of pressed tin. Every raw edge furnishes lodgement for dirt, which means food and home for putrefactive bacteria.

The sterilization of pails and cans used about the dairy is essential in the production of milk which is to have good keeping qualities. In order to sterilize, boiling water or live

steam is necessary, preferably the latter. This may be used by inverting the vessel over the steam jet or by placing the article to be sterilized in an oven which is nearly steam tight. There are on the market immense autoclaves for this purpose, but they are not essential to success. A concrete or even wooden box built at very nominal expense will serve nearly if not quite as well. It is desirable that such sterilizer boxes be provided with a door on either side so that the freshly washed dairy tools may be put into the sterilizer from the wash room side and removed from the milk bottling side of the room.

Fig. 86.—Milk pails. No. 1 is the common open mouth kind. Some are too high and sharp for comfort in milking. That on either end of the lower row is a very good pail.

Strainers are at best a crude attempt to undo something which should not have been necessary. Strainers as ordinarily made cause the hairs, chaff and other coarse dirt to be washed thoroughly as each successive pail is poured over them. The best sort of strainer is a broad one consisting of a layer of absorbent cotton between two sheets of clean cheese cloth.

A clean barn is a material aid in the production of clean milk (Figs. 87, 88 and 89). Right here, however, distinction

needs to be made between apparent and real dirtiness. Bacteria cannot rise from a moist or wet floor, neither will they long remain floating in a damp atmosphere. Therefore, if a stable floor is not so dirty as to allow pieces of filth to be picked up by the cow and carried to the pail, a floor which is apparently very dirty, but moist, may be of less consequence than a thoroughly

Fig. 87.—Typical and inexpensive well-made Southern cow stable. Note the open corn crib construction of south side (left) and ventilation loft at right. Owned by Mr. Van Dyke, Hope, Arkansas. (Photographed by author.)

dry and apparently cleaner condition. Fine, dry dust adheres to the hair of the cow as she lies in her bed and is with difficulty removed by hand or brush before milking. A stable atmosphere filled with dust from old hay is bad.

Flies are filthy things at best. They breed in the manure and carry portions of it on their bodies wherever they go. A fly swimming in milk or lying in a strainer soon becomes

washed fairly clean. The germs with which it was more or less covered become dissolved free from the dirt and disseminated throughout the entire mass of milk. Flies may be prevented around the stable and country home to some extent by careful removal of barnyard manure and other waste. Attempts are also being made to kill the larva or maggot in the manure heap by sprinkling over it powdered borax, also by con-

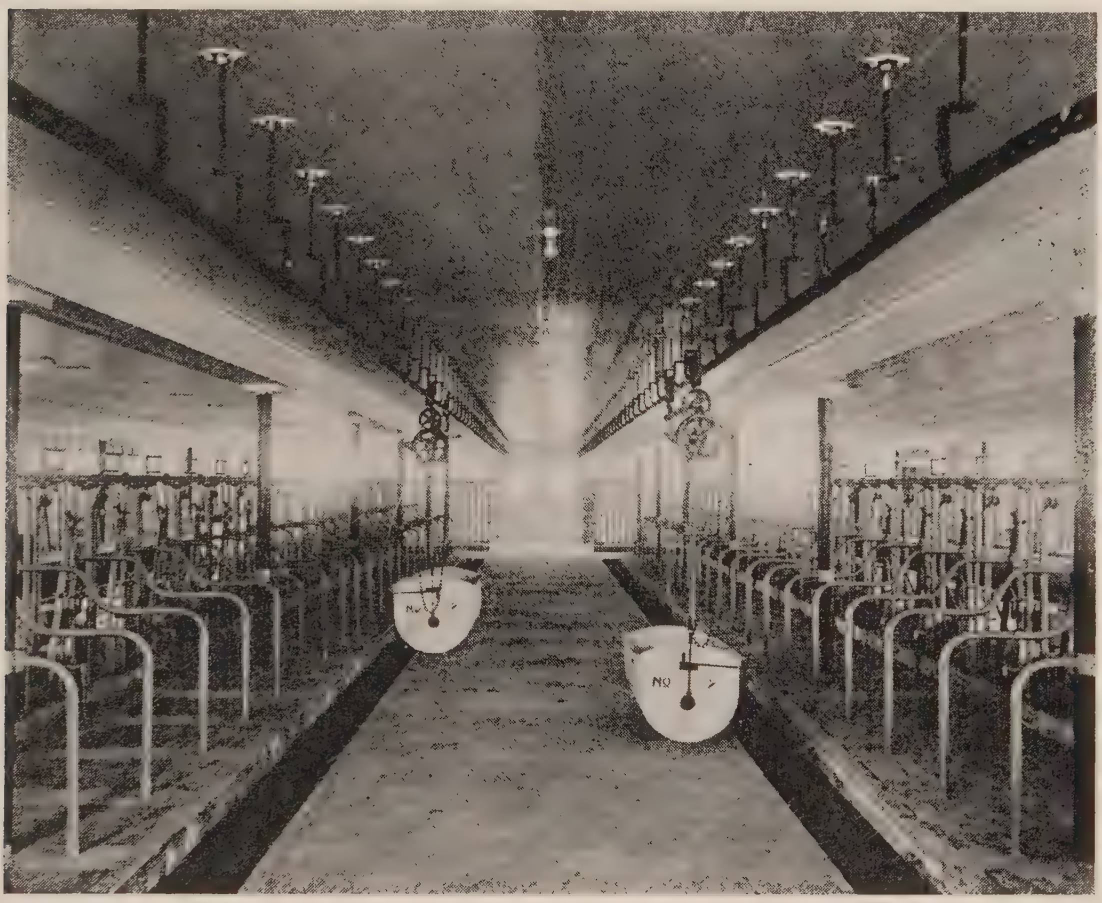


Fig. 88.—Stable, cows facing outward. Note method of building in the blocks for the cows to stand on. (Courtesy James Mfg. Co.)

structing cement pits over which the manure is laid on slats. The larvæ fall through and are killed in the kerosene water below. After flies have reached the adult form some may be caught by means of various fly traps. About the stable and back door of the kitchen and like places more effective extermination of flies can probably be brought about by poisoning, one of the best means known to the writer being skim milk into which formaldehyde has been stirred at the rate of three tea-

spoonfuls to each pint of milk. The greatest aid of all toward a flyless farm is the removal of manure daily to the field. This is impracticable under many circumstances, but the knowledge of the facts should lead to efforts in that direction.

Pure water is highly desirable. This is particularly so if the cows are permitted to wade into the water to drink. It is quite as much the contamination of the udder and teats of the cow as the drinking of bad water which causes inferiority in the milk produced. Clean water for the cow is necessary to the production of the best flavored milk.

Fig. 89.—Inexpensive yet clean cow house. Note liberal use of whitewash. Owned by F. Gruenhagen, Brainerd, Minn. (Photographed by author.)

Quick thorough cooling is the second most important single item in the production of milk which shall stay sweet (Fig. 90). Keeping the dirt out is of first importance. Various sorts of coolers have been devised, many having merit. Where abundance of flowing cold water is obtainable a cooler of the form shown in figure 113 is desired, but where flowing water is not at hand one of the type shown in figure 114, which when filled with water will admit also a chunk of ice, is desirable. Either of these forms will do good work when the water is sufficiently cold and the milk is not forced over too rapidly. It is naturally important that there be no blowing of dust

against this surface during cooling, otherwise precautions taken during milking may be largely nullified.

Cold water tanks of some form are necessary on practically all milk-producing farms. The efficiency of cold water over air of the same temperature as cooling agent can hardly be overestimated. A cold water tank will be found necessary during the summer and even all winter in some sections. The ideal tank would be one made of cement placed low in the milk room, thus obviating the necessity of lifting the cans high. If it is not possible to pump water through this tank for the stock, even greater efficiency in cooling may be got by placing in the tank-water a few chunks of ice. A well insulated tank filled with water in which are floating several cakes of ice forms the most

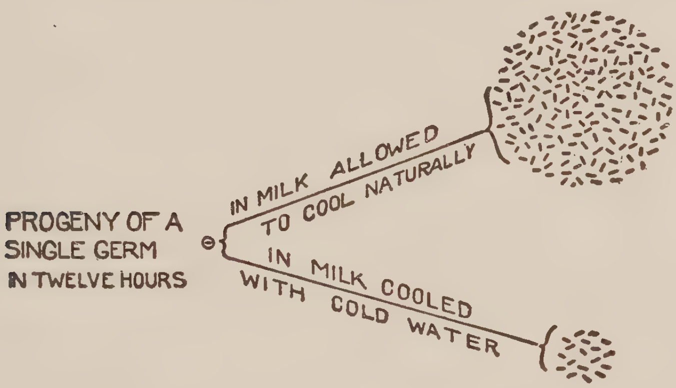


Fig. 90.—Showing the effect of prompt cooling on the number of bacteria in milk.

economical and efficient method known for keeping milk sweet.

Shipping.—Much remains to be accomplished in the matter of shipping milk. No matter how much care has been bestowed during the milking process some dirt, which means some germs, is sure to find its way into the milk, though germs are held down or prevented from growing by the cold temperature immediately given. They are present, however, to grow the moment the milk becomes warm enough and this point is reached at about 50 degrees. At 60 degrees the lactic acid germ grows rapidly. Cans of milk delivered to the railroad station and there allowed to stand in the sun very soon warm to such a point that the bacteria within commence growing rapidly. Insulating jackets are on the market which aid considerably, but these are

somewhat expensive and crude after all. Shipping cans made with double walls are also on the market, but, being valuable, are liable to be lost. This naturally discourages the shipper who endeavors to do especially good work. Where possible it is highly desirable that the company purchasing the milk or the farmers in some co-operative arrangement provide a cold waiting room for the milk at the station and then that the transportation company provide well iced cars for the milk during transit. Only by providing these final arrangements can the efficient work done earlier in the process be supported and sound milk be delivered to the receiving companies in the cities.

The New York Classes of Milk.—The city of New York established three grades of milk, as follows:

Grade "A"—For Infants and Children.—1. *Raw.—Requirements.*—Cows to be tuberculin tested and physically examined. Milk not to contain more than 60,000 bacteria per c.c. when delivered (Fig. 90). Dairies to score not less than 75, 25 on equipment and 50 on method. Delivered within 36 hours. Bottled. Labeled "Grade A Raw."

2. *Pasteurized.*—Cows physically examined.—Milk not to contain more than 30,000 bacteria per c.c. when delivered; not more than 200,000 before pasteurized. Pasteurization to be done at 142 to 145 degrees Fahrenheit for 30 minutes. Dairies to score not less than 68 per cent, 25 on equipment and 43 on method. Delivered 36 hours from production. Bottled. Labeled "Grade A Pasteurized."

Grade "B" for Adults.—1. Cows to be physically examined.—Not more than 1,500,000 bacteria per c.c. when pasteurized, nor more than 100,000 bacteria per c.c. when delivered. Pasteurized at 142 to 145 degrees—30 minutes. Dairies to score not less than 55 per cent, 20 on equipment and 35 on method. Delivered before 36 hours old (cream may be 72 hours old). May be delivered in bottles, or cans, labeled "Grade B Pasteurized."

Grade "C"—For Cooking and Manufacturing.—1. Cows physically examined.—Bacteria not more than 1,500,000 per

c.c. when pasteurized, nor more than 300,000 per c.c. when delivered. To be pasteurized at 145 degrees for 30 minutes. Dairies to score 40 points. Delivery in 48 hours after pasteurization. Shall be delivered in cans. Labeled "Grade C (for cooking)."

2. *Condensed Skimmed Milk.*—Cans to be painted blue, etc.

Dairy Score Card.—The score card system of comparing the cleanliness of dairy barns and the methods of handling the product is of value not only for the direct purpose of comparison but to point out as well to the workers in the dairy where to look for trouble.

Various score cards have been devised, but the one that was developed by the Federal Dairy Division and approved by the Official Dairy Instructors' Association has been most widely adopted. The score card from Rochester, New York, is typical of the one in most general use (see pp. 276–277).

Material vs. Method.—While the dairy score card has its uses it must not be judged that a high scoring stable will produce high scoring milk, or that a low scoring stable necessarily means low scoring milk. There is no relationship between expensiveness of barn and quality of milk produced and very little between score and quality. This becomes true because the methods employed are so much more important than the material. A silk garment may be soiled and a cotton one the acme of cleanliness.

QUESTIONS

1. How may the pasture drinking pond affect the sanitary character of the milk produced?
2. What points of cleanliness should the milker observe?
3. What points about a milk pail are important in clean milk production?
4. Distinguish between real and apparent dirtiness in stables.
5. Where do flies breed? Name one good poison for them.
6. What effect does the purity of water drunk by the cow have upon the quality of the milk produced?
7. What is the second most important point in the production of good milk? What is the first?
8. How should milk or cream be kept cool?
9. What precautions should be taken in shipping milk into the cities?
10. Discuss the score card used for dairy barn and milk rooms.

Score Card for Dairies

(Rochester Health Bureau, New York State Department of Health)
[Indorsed by the Official Dairy Instructors' Association. Subject to revision at future meetings.]

Owner or lessee of farm..

P. O. address..................................County..........................

Total number of cows........Number milking......Gallons of milk produced daily......

Product is sold by producer in families, hotels, restaurants, stores, to.............dealer

For milk supply of...

Permit No..........................Date of inspection.......................,19

Remarks:...

....

....

....

....

Equipment	Score: Perfect	Score: Allowed
COWS		
Health..................	6	....
Apparently in good health.............1		
* If tested with tuberculin within a year and no tuberculosis is found, or if tested within six months and all reacting animals removed......5		
(If tested within a year and reacting animals are found and removed, 3.)		
Food (clean and wholesome).................	1	....
Water (clean and fresh)...	1	....
STABLES		
Location of stable........	2	....
Well drained.........1		
Free from contaminating surroundings....1		
Construction of stable....	4	....
Tight, sound floor and proper gutter.......2		
Smooth, tight walls and ceiling.............1		
Proper stall, tie, and manger...........1		
Provision for light: Four sq. ft. of glass per cow	4	....
(Three sq. ft., 3; 2 sq. ft., 2; 1 sq. ft., 1. Deduct for uneven distribution.)		
Bedding...............	1	....

Methods	Score: Perfect	Score: Allowed
COWS		
Clean..................	8	....
(Free from visible dirt, 6.)		
STABLES		
Cleanliness of stables.....	6	....
Floor...............2		
Walls...............1		
Ceilings and ledges....1		
Mangers and partitions 1		
Windows.............1		
Stable air at milking time.	5	....
Freedom from dust....3		
Freedom from odors...2		
Cleanliness of bedding...	1	....
Barnyard...............	2	....
Clean................1		
Well drained.........1		
Removal of manure daily to 50 feet from stable..	2	....
MILK ROOM OR MILK HOUSE		
Cleanliness of milk room.	2	....
UTENSILS AND MILKING		
Care and cleanliness of utensils............	8	....
Thoroughly washed...2		
Sterilized in steam for 15 minutes.........3		
(Placed over steam jet, or scalded with boiling water, 2.)		

(*Score Card for Dairies.*—Continued)

EQUIPMENT	SCORE Perfect	SCORE Allowed
Ventilation..............	7	....
Provision for fresh air, controllable flue system 3		
(Windows hinged at bottom, 1.5; sliding windows, 1; other openings, 0.5.)		
Cubic feet of space per cow, 500 ft.........3		
(Less than 500 ft., 2; less than 400 ft., 1; less than 300 ft., 0.)		
Provision for controlling temperature........1		
UTENSILS		
Construction and condition of utensils........	1	....
Water for cleaning.......	1	....
(Clean, convenient, and abundant.)		
Small-top milking pail....	5	....
Milk cooler..............	1	....
Clean milking suits.......	1	....
MILK ROOM OR MILK HOUSE		
Location: Free from contaminating surroundings	1	....
Construction of milk room	2	....
Floor, walls and ceiling 1		
Light, ventilation, screens............1		
Separate rooms for washing utensils and handling milk..................	1	....
Facilities for steam.......	1	....
(Hot water, 0.5.)		
Total..............	40	....

METHODS	SCORE Perfect	SCORE Allowed
Protected from contamination.............3		
Cleanliness of milking....	9	....
Clean, dry hands.....3		
Udders washed and wiped.............6		
(Udders cleaned with moist cloth, 4; cleaned with dry cloth or brush at least 15 minutes before milking, 1.)		
HANDLING THE MILK		
Cleanliness of attendants in milk room..........	2	....
Milk removed immediately from stable without pouring from pail..	2	....
Cooled immediately after milking each cow......	2	....
Cooled below 50° F.....	5	....
(51° to 55°, 4; 56° to 60°, 2.)		
Stored below 50° F......	3	....
(51° to 55°, 2; 56° to 60°, 1.)		
Transportation below 50° F................	2	....
(51° to 55°, 1.5; 56° to 60°, 1.)		
(If delivered twice a day, allow perfect score for storage and transportation.)		
Total..............	60	....

* Alternate. If pasteurized by holding process according to the Sanitary Code, Chap. III, Reg. 12; score, 5.

Equipment.............. + Methods.............. = ...Final Score

NOTE 1—If any exceptionally filthy condition is found, particularly dirty utensils, the total score may be further limited.

NOTE 2—If the water is exposed to dangerous contamination, or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

.............................*Inspector.*

CHAPTER XXVI

METHODS AND STANDARDS FOR THE PRODUCTION AND DISTRIBUTION OF CERTIFIED MILK*

(Adopted by the American Association of Medical Milk Commissions, May 1, 1912.)

HYGIENE OF THE DAIRY

Under the Supervision and Control of the Veterinarian.

1. **Pastures or Paddocks.**—Pastures or paddocks to which the cows have access shall be free from marshes or stagnant pools, crossed by no stream which might become dangerously contaminated, at sufficient distance from offensive conditions to suffer no bad effects from them, and shall be free from plants which affect the milk deleteriously.

2. **Surroundings or Buildings.**—The surroundings of all buildings shall be kept clean and free from accumulations of dirt, rubbish, decayed vegetable or animal matter or animal waste, and the stable yard shall be well drained.

3. **Location of Buildings.**—Buildings in which certified milk is produced and handled shall be so located as to insure proper shelter and good drainage, and at sufficient distance from other buildings, dusty roads, cultivated and dusty fields, and all other possible sources of contamination; provided, in the case of unavoidable proximity to dusty roads or fields, the exposed side shall be screened with cheesecloth.

4. **Construction of Stables.**—The stables shall be constructed so as to facilitate the prompt and easy removal of waste products (Fig. 91). The floors and platforms shall be made of cement or other nonabsorbent material and the gutters of cement only. The floors shall be properly graded and drained, and the manure gutters shall be from 6 to 8 inches deep and so placed in relation to the platform that all manure will drop into them (Fig. 92).

5. **The inside surface of the walls** and all interior construc-

* U. S. Dept. of Agriculture, Bulletin No. 1, 1913.

tion shall be smooth, with tight joints, and shall be capable of shedding water. The ceiling shall be of smooth material and dust tight. All horizontal and slanting surfaces which might harbor dust shall be avoided.

6. **Drinking and Feed Troughs.**—Drinking troughs or basins shall be drained and cleaned each day, and feed and mixing troughs shall be kept in a clean and sanitary condition.

Fig. 91.—Well-finished dairy barn on farm of F. O. Lowden, Oregon, Ill. (Courtesy James Mfg. Co.)

7. **Stanchions.**—Stanchions, when used, shall be constructed of iron pipes or hardwood, and throat latches shall be provided to prevent the cows from lying down between the time of cleaning and the time of milking.

8. **Ventilation.**—The cow stables shall be provided with

adequate ventilation either by means of some approved artificial device, or by the substitution of cheesecloth for glass in the windows, each cow to be provided with a minimum of 600 cubic feet of air space.

9. **Windows.**—A sufficient number of windows shall be installed and so distributed as to provide satisfactory light and a maximum of sunshine, 2 feet square of window area to each

FIG. 92.—These cows keep themselves clean by stepping forward to lie down in front of the 2 x 4-inch stringer which holds the bedding in place. Note the broad shallow gutter, safe and easy to clean. (Owned by C. C. Graves, Maryville, Mo.)

600 cubic feet of air space to represent the minimum. The coverings of such windows shall be kept free from dust and dirt.

10. **Exclusion of Flies, Etc.**—All necessary measures should be taken to prevent the entrance of flies and other insects and rats and other vermin into all the buildings.

11. **Exclusion of Animals from the Herd.**—No horses, hogs, dogs, or other animals or fowls shall be allowed to come in

contact with the certified herd, either in the stables or elsewhere.

12. **Bedding.**—No dusty or moldy hay, or straw, bedding from horse stalls, or other unclean animals shall be used for bedding the cows. Only bedding which is clean, dry, and absorbent may be used, preferably shavings or straw.

13. **Cleaning Stable and Disposal of Manure.**—Soiled bedding and manure shall be removed at least twice daily, and the floors shall be swept and kept free from refuse. Such cleaning shall be done at least one hour before the milking time. Manure, when removed, shall be drawn to the field or temporarily stored in containers so screened as to exclude flies. Manure shall not be even temporarily stored within 300 feet of the barn or dairy building (Fig. 93).

14. **Cleaning of Cows.**—Each cow in the herd shall be groomed daily, and no manure, mud, or filth shall be allowed to remain upon her during milking; for cleaning, a vacuum apparatus is recommended.

15. **Clipping.**—Long hairs shall be clipped from the udder and flanks of the cow and from the tail above the brush. The hair on the tail shall be cut so that the brush may be well above the ground.

16. **Cleaning of Udders.**—The udders and teats of the cow shall be cleaned before milking; they shall be washed with a cloth and water, and dry wiped with another clean sterilized cloth—a separate cloth for drying each cow.

17. **Feeding.**—All feedstuffs shall be kept in an apartment separate from and not directly communicating with the cow barn. They shall be brought into the barn only immediately before feeding hour, which shall follow the milking.

18. **Only those feeds** shall be used which consist of fresh, palatable, or nutritious materials, such as will not injure the health of the cows or unfavorably affect the taste or character of the milk. Any dirty or moldy feed or feed in a state of decomposition or putrefaction shall not be given.

19. **A well-balanced ration** shall be used, and all changes of feed shall be made slowly. The first few feedings of grass,

Fig. 93.—Clean, healthy cows from a clean yard are prepared to yield the choicest food for children. (Owned by C. C. Graves, Maryville, Missouri.)

alfalfa, ensilage, green corn, or other green feeds shall be given in small rations and increased gradually to full ration.

20. **Exercise.**—All dairy cows shall be turned out for exercise at least two hours in each twenty-four in suitable weather. Exercise yards shall be kept free from manure and other filth.

21. **Washing of Hands.**—Conveniently located facilities shall be provided for the milkers to wash their hands before and during milking.

22. **The hands of the milkers** shall be thoroughly washed with soap, water, and brush and carefully dried on a clean towel immediately before milking. The hands of the milkers shall be rinsed with clean water and carefully dried before milking each cow. The practice of moistening the hands with milk is forbidden.

23. **Milking Clothes.**—Clean overalls, jumper, and cap shall be worn during milking. They shall be washed or sterilized each day and used for no other purpose, and when not in use they shall be kept in a clean place, protected from dust and dirt.

24. **Things to be Avoided by Milkers.**—While engaged about the dairy or in handling the milk employees shall not use tobacco nor intoxicating liquors. They shall keep their fingers away from their nose and mouth, and no milker shall permit his hands, fingers, lips, or tongue to come in contact with milk intended for sale.

25. During milking the milkers shall be careful not to touch anything but the clean top of the milking stool, the milk pail, and the cow's teats.

26. Milkers are forbidden to spit upon the walls or floors of stables, or upon the walls or floors of milk houses, or into the water used for cooling the milk or washing the utensils.

27. **Fore Milk.**—The first streams from each teat shall be rejected, as this fore milk contains large numbers of bacteria. Such milk shall be collected into a separate vessel and not milked onto the floors or into the gutters. The milking shall be done rapidly and quietly, and the cows shall be treated kindly.

28. **Milk and Calving Period.**—Milk from all cows shall be

excluded for a period of 45 days before and 7 days after parturition.

29. **Bloody and Stringy Milk.**—If milk from any cow is bloody and stringy or of unnatural appearance, the milk from that cow shall be rejected and the cow isolated from the herd until the cause of such abnormal apearance has been determined and removed, special attention being given in the meantime to the feeding or to possible injuries. If dirt gets into the pail, the milk shall be discarded and the pail washed before it is used.

30. **Make-up of Herd.**—No cows except those receiving the same supervision and care as the certified herd shall be kept in the same barn or brought in contact with them.

31. **Employees Other Than Milkers.**—The requirements for milkers, relative to garments and cleaning of hands, shall apply to all other persons handling the milk, and children unattended by adults shall not be allowed in the dairy nor in the stable during milking.

32. **Straining and Strainers.**—Promptly after the milk is drawn it shall be removed from the stable to a clean room (Fig. 94), and then emptied from the milk pail to the can, being strained through strainers made of a double layer of finely meshed cheesecloth or absorbent cotton thoroughly sterilized. Several strainers shall be provided for each milking in order that they may be frequently changed.

33. **Dairy Building.**—A dairy building shall be provided which shall be located at a distance from the stable and dwelling prescribed by the local commission, and there shall be no hog-pen, privy, or manure pile at a higher level or within 300 feet of it.

34. The dairy building shall be kept clean and shall not be used for purposes other than the handling and storing of milk and milk utensils (Figs. 95 and 119). It shall be provided with light and ventilation, and the floors shall be graded and water-tight.

35. The dairy building shall be well lighted and screened and drained through well-trapped pipes. No animals shall be allowed therein. No part of the dairy building shall be used for dwelling or lodging purposes, and the bottling room shall

be used for no other purpose than to provide a place for clean milk utensils and for handling the milk. During bottling this room shall be entered only by persons employed therein. The bottling room shall be kept scrupulously clean and odorless.

36. **Temperature of Milk.**—Proper cooling to reduce the temperature to forty-five degrees F. shall be used, and aërators shall be so situated that they can be protected from flies, dust, and odors. The milk shall be cooled immediately after being milked, and maintained at a temperature between thirty-five and forty-five degrees F. until delivered to the consumer.

FIG. 94.—Elevation of certified milk house showing arrangement of milk spout through the wall from the weigh room into the milk room. There is no door connecting the two rooms.

37. **Sealing of Bottles.**—Milk, after being cooled and bottled, shall be immediately sealed in a manner satisfactory to the commission, but such seal shall include a sterile hood which completely covers the lip of the bottle.

38. **Cleaning and Sterilizing of Bottles.**—The dairy building shall be provided with approved apparatus for the cleansing and sterilizing of all bottles and utensils used in milk production. All bottles and utensils shall be thoroughly cleaned by hot water and sal soda, or equally pure agent, rinsed until the cleaning water is thoroughly removed, then exposed to live steam or boiling water at least twenty minutes, and then kept inverted until used in a place free from dust and other contaminating materials.

39. **Utensils.**—All utensils shall be so constructed as to be easily cleaned. The milk pail should preferably have an elliptical opening 5 by 7 inches in diameter. The cover of this

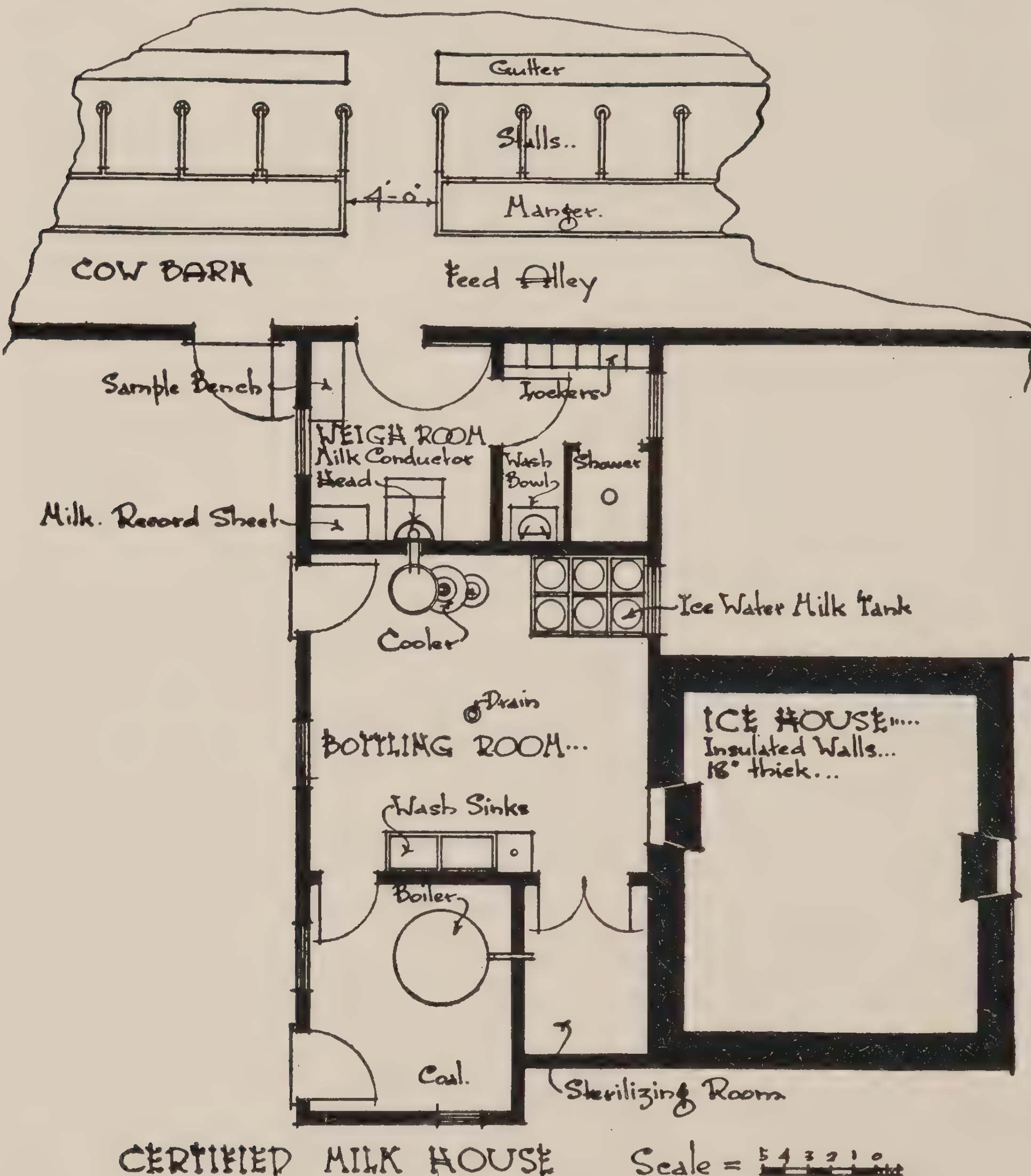


FIG. 95.—Plan of milk house connected to, yet separated from, the cow barn. There is no door between the weigh room and the milk room. (Adapted from the certified milk plant of "The Arden Farms," St. Paul, Minn.)

pail should be so convex as to make the entire interior of the pail visible and accessible for cleaning. The pail shall be made of heavy seamless tin, and with seams which are flushed and made smooth by solder. Wooden pails, galvanized-iron pails,

or pails made of rough, porous materials, are forbidden. All utensils used in milking shall be kept in good repair.

40. **Water Supply.**—The entire water supply shall be absolutely free from contamination, and be sufficient for all dairy purposes. It shall be protected against flood or surface drainage, and shall be conveniently situated in relation to the milk house.

41. **Privies, etc., in Relation to Water Supply.**—Privies, pig-pens, manure piles, and all other possible sources of contamination shall be so situated on the farm as to render impossible the contamination of the water supply, and shall be so protected by use of screens and other measures as to prevent their becoming breeding grounds for flies.

42. **Toilet Rooms.**—Toilet facilities for the milkers shall be provided and located outside of the stable or milk house. These toilets shall be properly screened, shall be kept clean, and shall be accessible to wash basins, water, nail brush, soap and towels, and the milkers shall be required to wash and dry their hands immediately after leaving the toilet room.

TRANSPORTATION

43. In transit the milk packages shall be kept free from dust and dirt. The wagon, trays, and crates shall be kept scrupulously clean. No bottles shall be collected from houses in which communicable diseases prevail, unless a separate wagon is used and under conditions prescribed by the department of health and the medical milk commission.

44. All certified milk shall reach the consumer within thirty hours after milking.

VETERINARY SUPERVISION OF THE HERD

45. **Tuberculin Test.**—The herd shall be free from tuberculosis, as shown by the proper application of the tuberculin test. The test shall be applied in accordance with the rules and regulations of the United States Government, and all reactors shall be removed immediately from the farm.

46. No new animals shall be admitted to the herd without first having passed a satisfactory tuberculin test, made in accordance with the rules and regulations mentioned; the tuberculin

to be obtained and applied only by the official veterinarian of the commission.

47. Immediately following the application of the tuberculin test to a herd for the purpose of eliminating tuberculous cattle, the cow stable and exercising yards shall be disinfected by the veterinary inspector in accordance with the rules and regulations of the United States Government.

48. A second tuberculin test shall follow each primary test after an interval of six months, and shall be applied in accordance with the rules and regulations mentioned. Thereafter, tuberculin tests shall be reapplied annually, but it is recommended that the retests be applied semi-annually.

49. **Identification of Cows.**—Each dairy cow in each of the certified herds shall be labeled or tagged with a number or mark which will permanently identify her.

50. **Herd-book Record.**—Each cow in the herd shall be registered in a herd book, which register shall be accurately kept so that her entrance and departure from the herd and her tuberculin testing can be identified.

51. A copy of this herd-book record shall be kept in the hands of the veterinarian of the medical milk commission under which the dairy farm is operating, and the veterinarian shall be made responsible for the accuracy of this record.

52. **Dates of Tuberculin Tests.**—The dates of the annual tuberculin tests shall be definitely arranged by the medical milk commission, and all of the results of such tests shall be recorded by the veterinarian and regularly reported to the secretary of the medical milk commission issuing the certificate.

53. The results of all tuberculin tests shall be kept on file by each medical milk commission, and a copy of all such tests shall be made available to the American Association of Medical Milk Commissions for statistical purposes.

54. The properly designated officers of the American Association of Medical Milk Commissions should receive copies of reports of all of the annual, semi-annual, and other official tuberculin tests which are made and keep copies of the same on file and compile them annually for the use of the association.

55. **Disposition of Cows Sick with Disease Other Than Tuberculosis.**—Cows having rheumatism, leucorrhea, inflammation of the uterus, severe diarrhea, or disease of the udder, or cows that from any other cause may be a menace to the herd shall be removed from the herd and placed in a building separate from that which may be used for the isolation of cows with tuberculosis, unless such building has been properly disinfected since it was last used for this purpose. The milk from such cows shall not be used nor shall the cows be restored to the herd until permission has been given by the veterinary inspector after a careful physical examination.

56. **Notification of Veterinary Inspector.**—In the event of the occurrence of any of the diseases just described between the visits of the veterinary inspector, or if at any time a number of cows become sick at one time in such a way as to suggest the outbreak of a contagious disease or poisoning, it shall be the duty of the dairyman to withdraw such sickened cattle from the herd, to destroy their milk, and to notify the veterinary inspector by telegraph or telephone immediately.

57. **Emaciated Cows.**—Cows that are emaciated from chronic diseases or from any cause that in the opinion of the veterinary inspector may endanger the quality of the milk, shall be removed from the herd.

BACTERIOLOGICAL STANDARDS

58. **Bacterial Counts.**—Certified milk shall contain less than 10,000 bacteria per cubic centimeter when delivered. In case a count exceeding 10,000 bacteria per cubic centimeter is found, daily counts shall be made, and if normal counts are not restored within ten days the certificate shall be suspended.

59. Bacterial counts shall be made at least once a week.

60. **Collection of Samples.**—The samples to be examined shall be obtained from milk as offered for sale and shall be taken by a representative of the milk commission. The samples shall be received in the original packages, in properly iced containers, and they shall be so kept until examined, so as to limit as far as possible changes in their bacterial content.

61. For the purpose of ascertaining the temperature, a

separate original package shall be used, and the temperature taken at the time of collecting the sample, using for the purpose a standardized thermometer graduated in the centigrade scale. * * * * * * * * *

CHEMICAL STANDARDS AND METHODS

The methods that must be followed in carrying out the chemical investigations essential to the protection of certified milks are so complicated that in order to keep the fees of the chemist at a reasonable figure, there must be eliminated from the examination those procedures which, whilst they might be helpful and interesting, are in no sense necessary.

For this reason the determination of the water, the total solids and the milk sugar is not required as a part of the routine examination.

70. **The chemical analysis** shall be made by a competent chemist designated by the medical milk commission.

71. **Method of Obtaining Samples.**—The samples to be examined by the chemist shall have been examined previously by the bacteriologist designated by the medical milk commission as to temperature, odor, taste, and bacterial content.

72. **Fat Standards.**—The fat standard for certified milk shall be 4 per cent, with a permissible range of variation of from 3.5 to 4.5 per cent.

73. The fat standard for certified cream shall be not less than 18 per cent.

74. If it is desired to sell higher fat-percentage milks or creams as certified milks or creams, the range of variation for such milks shall be 0.5 per cent on either side of the advertised percentage and the range of variations for such creams shall be 2 per cent on either side of the advertised percentage.

75. The fat content of certified milks and creams shall be determined at least once each month.

* * * * * * * * *

87. **Specific Gravity.**—The specific gravity of certified milk shall range from 1.029 to 1.034.

88. The specific gravity shall be determined at least each month.

PART VI

FARM DAIRYING

CHAPTER XXVII

THE FARM MILK HOUSE

Any farmer with ten or more cows used for purposes of cream or milk production can ill afford to be without some clean and convenient place in which to separate the milk and keep the cream. The separator must be housed, preferably in a place free from dust and away from odors. The cream-cooling tank which occasionally is found in the yard by the pump, protected from sun and dust by old boards or a door, would last longer and preserve the cream better if inside a building. To keep the cream cool in summer and to prevent it from freezing in winter are both important. If we add to these concrete advantages the further fact that far more pleasure and satisfaction can be got from work when performed in a more definite and sanitary way, we have ample reason to encourage the construction of modest dairy buildings. The cost will vary with the requirements, from about seventy-five dollars up, but the interest on the investment may be many times made during the year through saving milk or cream which otherwise would be damaged or even spoiled.

REQUIREMENTS

Plan " A " for Ten to Twenty Cows.—Where a separator is turned by hand, milk fed out while fresh and cream sold from two to three times a week, a building need be only 10 by 10 feet in size and provided inside with a separator on a deep foundation with a well insulated tank for holding the cream in cold water and a small table on which to work. If it is desired with this to have a small gasoline engine the building should be made about two feet longer, or 10 by 12 feet, as shown in plan " A." It is preferable that the engine be kept in an adjoining room.

The cost of the material for this house will be approximately $90 and the labor, if done by a carpenter, about $50, or a total of about $140.

Plan " B " for Fifteen to Thirty Cows.—Whenever twenty

or more cows are used in the dairy it is highly desirable indeed that most, if not all, of the work, such as cleaning separator and cans, be done in the dairy house rather than in the kitchen. It is also very desirable that the well be located in conjunction with it. This will necessitate an engine for the running of the separator and occasional pumping, an upright boiler, washing sink, pail racks, and a Babcock milk tester outfit.

To use this quantity of equipment a milk house at least 10 by 18 feet will be needed and one 12 by 20 feet will be none too large for convenience. Plan " B " is designed to indicate size and arrangement of building for plant of this size. If the boiler or water heater is not installed the space occupied by the boiler and fuel bin may very conveniently be used as a work bench.

The material will cost about $150 and the labor about $100 more, making a total cost of about $250.

Plan " C " for Twenty-five to Fifty Cows with Ice House Attached.—There are occasionally farms in which a somewhat more efficient, if more expensive, building is desired. In plan " C " it will be noticed that the end of the milk house encloses the base of the windmill tower and that within this space is located the boiler, engine, and pump and that on the opposite end of the building is the ice house. This may be of the old sort, namely, of cheap lumber with the ice buried in saw dust; but preferably, the ice house may be insulated so thoroughly that the ice within will keep well without being covered by saw dust or any other material. The milk house proper is set between the two, the engine house and the ice house (Figs. 96 and 97).

Where the milk house can be located at a distance not too great from the dwelling house it will be found exceedingly convenient to have a small refrigerator room built against the side of the insulated ice house with conductor pipes leading from the floor of the refrigerator to the floor of the ice house and from the top of the refrigerator back into the farther side and top of the ice room (Fig. 98). This will provide a circulation of cold air such as to maintain a temperature of 40 degrees or lower in the refrigerator room, providing, of course, it is reasonably well insulated, and will at the same time keep the room dry.

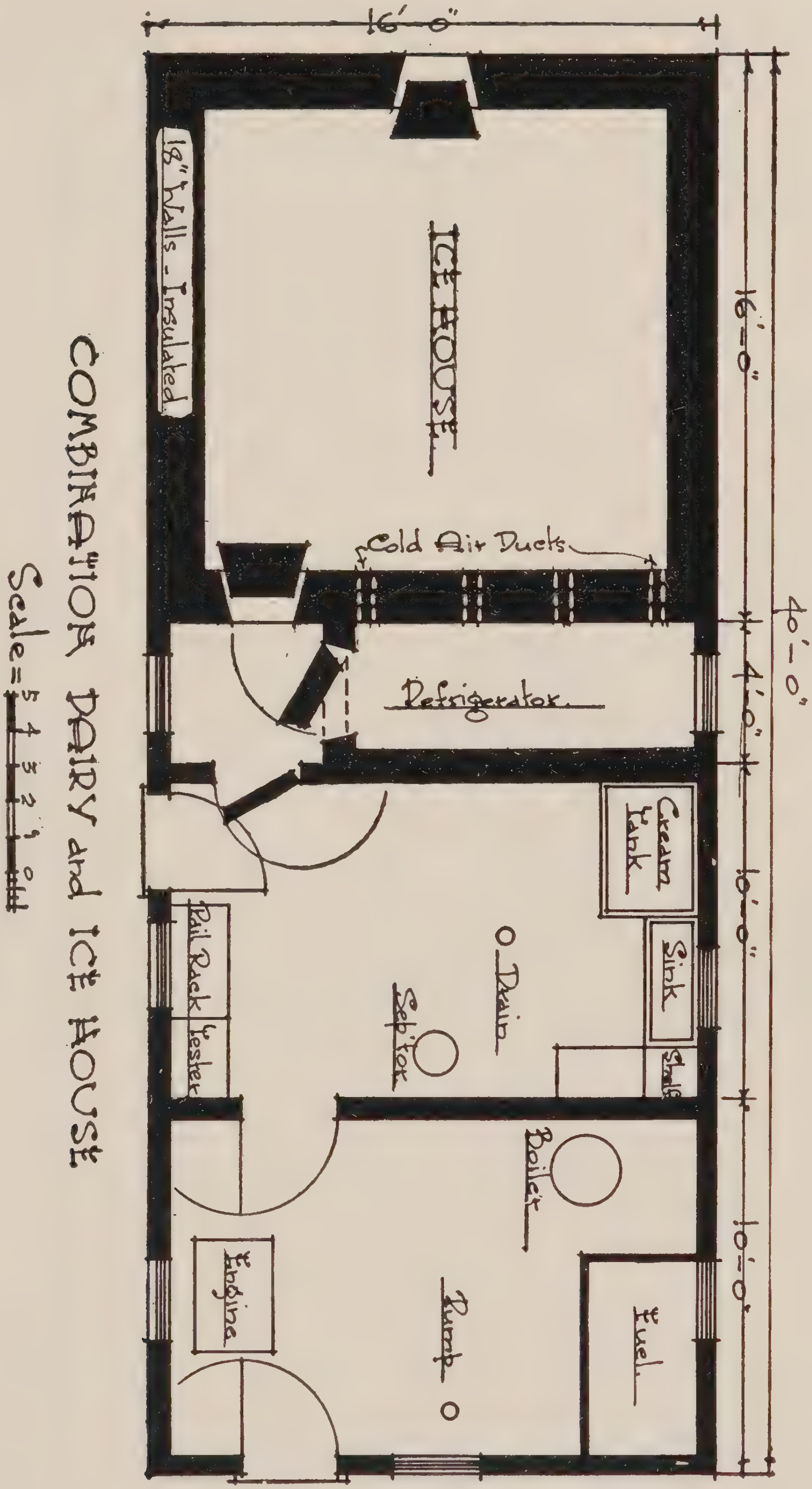


Fig. 96.—Plan for dairy and ice house combined.

The ice chute at one side is provided in order that the ice may be taken out of the ice house without exposing the cold interior to the outdoor weather. It is also an entry for the cold room to save waste of cold air. A simple ladder may be constructed on the wall of the chute next to the refrigerator room. A series of doors in the side of the ice house, somewhat after the manner of a silo, provides means for throwing the ice out. A plank floor should be made at the bottom of the chute where the ice will be found easily available for use in the cream tank, or ready for any use. The ice house if filled ten feet high will hold about 35 tons of ice. Built of wood with cement floor reasonably well made, this building will cost approximately $400.

Fig. 97.—Combination ice, dairy and power house on farm of F. Gruenhagen, Brainerd, Minn. (Photo by author.)

The cold water tank for keeping milk and cream sweet is about the most important single piece of equipment about the dairy. This tank under most circumstances should be located in such a place that all water pumped for the stock shall first flow through this tank around the cans of cream and milk. In this way the cream gets the "cold" and the animals are provided with the more temperate water and both are benefited thereby.

Where eight-gallon or ten-gallon cans are to be handled it is wise where possible to build the tank low in the cement floor to avoid excessive lifting. The sides of the tank may well be built up some six or eight inches above the floor level.

To keep the cans from tipping when not full, compartments may be built by means of galvanized iron pipes, coupled to

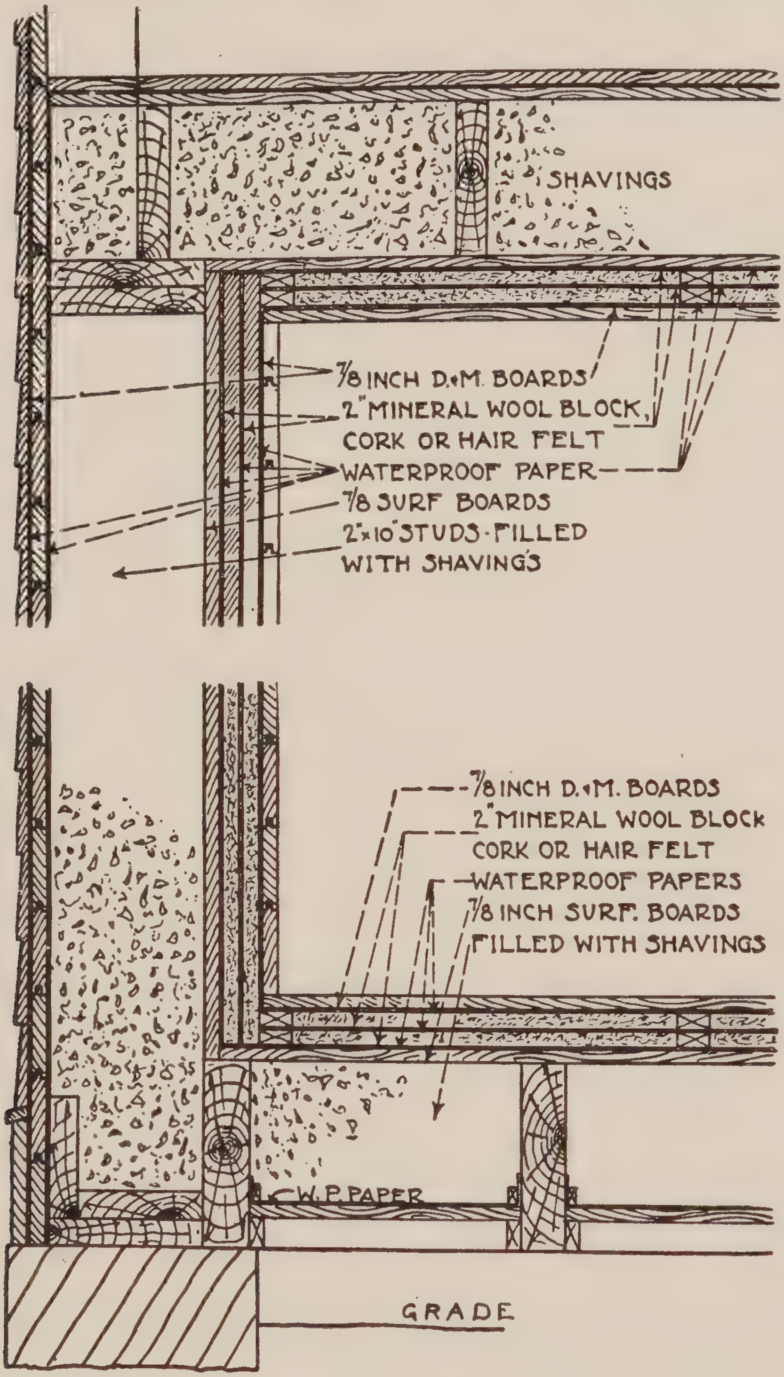


Fig. 98.—Showing method of insulating the walls in the insulated ice house. Reproduced from "Practical Cold Storage," by Madison Cooper. (Published by Nickerson and Collins Co., Chicago.)

branch out between the cans. Spaces should be of such size as to accommodate the ordinary four-gallon " shot-gun " can (eight to nine inches in diameter and twenty inches high) and the ordinary

ten-gallon shipping can (fourteen inches in diameter and twenty inches high).

Two-inch wood makes a good tank. The extra expense incurred in providing thick non-conducting walls is soon repaid by improved quality in the cream or a saving of ice.

Milk and cream become sour and otherwise damaged through the action of certain bacteria. To grow at all rapidly, all bacteria require a temperature of at least 55 degrees F. Cream keeps sweet more easily than milk, yet it will sour quickly if allowed to stand at a temperature of 55 degrees or warmer. To remain sweet for several days, even very clean cream must be held at a temperature of 50 degrees or lower. The ordinary kitchen ice chest seldom cools to a temperature lower than 55 degrees and is more often at 60 degrees. To keep milk most efficiently the cans or bottles should be placed into water in which chunks of ice are floating (Fig. 131).

Deep well water is usually cold enough in the northern states so that if caused to flow around the cans of cream the temperature of the whole may be very cheaply held low enough, but when such an arrangement is impractical ice should be used in the tanks of water, in which case insulation of the tank is especially desirable.

A sterilizer of some sort is essential in the production and delivery of good milk or cream. A steam jet through the drain board of the sink is ample for most farm dairy needs, but a galvanized iron oven, or a tight room, preferably made of cement, is a good investment, since in these ovens all of the dairy tools may be subjected to the purifying influence of live steam.

LOCATION

The milk room should not be located in the barn, but should be close to the door through which the milk can be most conveniently brought (Fig. 94). It is essential, however, that good drainage be provided. It is desirable that the space between the barn and the milk house be sufficiently wide to permit a wagon to be easily driven between. The sidewalk leading from the barn door to the milk room door may be covered if desired. Not infrequently the entire space between the barn and the milk

house is provided with roof and concrete floor, thus making a convenient place for the loading of the milk wagon, providing such is used. Care should be taken that the milk house is not located at too great a distance from the barn unless it is towards the calf stable and hog house, since milk is such heavy stuff to carry. In the location of the building, as well as with the arrangement of the various features within, the object should be to economize steps (Fig. 95).

MATERIAL AND CONSTRUCTION

The material of which the milk house is to be made naturally will vary, but in most instances will probably be wood, though at present there is considerable use being made of the cement plaster, stucco finish. When not inconvenient the milk house should be made to harmonize in material and color with the other buildings surrounding it. Cement blocks are also coming into use very largely and certainly have a place. Likewise, hollow clay blocks are beginning to be used to some extent and like the cement blocks have the advantage of permanency. In any case the floor of the milk house should be concrete, made with sufficient fall towards the drain to insure the quick removal of any water.

The cement foundation walls should be comparatively high to keep the wood sill, if such be used, well above the constant moisture and the floor within should be made with round corners up to the top of the foundation wall, some eighteen inches to two feet above ground. Above this point, inside and over the ceiling, comparatively rich cement plaster may be used, but the disadvantage of this is that fine bits of sand will continue to fall on whatever machinery may be situated below. It is recommended, therefore, that the inner walls be made of wood and then painted heavily, first with a white filler, and then with a comparatively heavy white enamel paint. This provides a clean bright interior, permits shelves to be put up where necessary and saves the various machines and the cream below from being sprinkled with sand, as would be the case if common cement plaster were used.

Since to work quickly and to take pride in it one must be able to see well, it is necessary that a reasonable amount of light be provided. There should be at least two windows in order to pro-

vide ventilation when needed. These should be well screened. It will be found convenient also in summer to have heavy roller shades or some other means of darkening the room. This will assist in driving the flies out of the place and also in keeping the room cool. No particular attention need be paid to ventilation except in the largest of the plants indicated, where a ventilating flue should be provided in wash room to assist in drying the room as well as in giving workmen better air.

In any milk house, especially in the little, inexpensive ones (Fig. 99), the foundation upon which the separator is set should extend into the ground below the frost line. This is accomplished by setting posts upon which the four legs of the separator are to stand and then cementing up around them. If this is not done the cement floor will heave with freezing sufficiently to throw the separator badly out of line and cause trouble.

THE FARM ICE HOUSE

When it is realized that cream, sweet and otherwise of good flavor, is worth from 10 to 20 per cent more than the same would be in a stale condition; that under the present American farm conditions one dollar invested in ice at the beginning of the season will return from five to ten dollars in increased value of the cream for each and every cow on the farm, the ice house will become more common.

Water weighs 62½ pounds to the cubic foot, ice 57.5 pounds. One ton of solid ice requires 35 cubic feet of space or, as ordinarily well packed, about 50 cubic feet. If the milk is separated immediately after being drawn and only the cream cooled, one-half ton of ice will suffice to cool the cream of one cow for one season of six months, or allowing for usual melting and other waste, one ton of ice occupying approximately 50 cubic feet of space will suffice for each cow. A herd of ten cows, therefore, would require 500 cubic feet of ice space or a building which will accommodate a mass of ice $8 \times 8 \times 8$ feet. Naturally, if ice is to be used for household and other purposes, extra accommodation will need to be provided.

The old sort of cheaply made ice house (Fig. 100), which consisted essentially of a bin of sawdust with a roof over it, is

wasteful of ice and an unpleasant place from which to remove ice. The heavy and disagreeable nature of the work of removing the ice after it is stored undoubtedly has much to do with the scarcity of ice houses even in our well-watered northern sections. Most of this trouble may be easily avoided by the construction of the so-called insulated ice house.

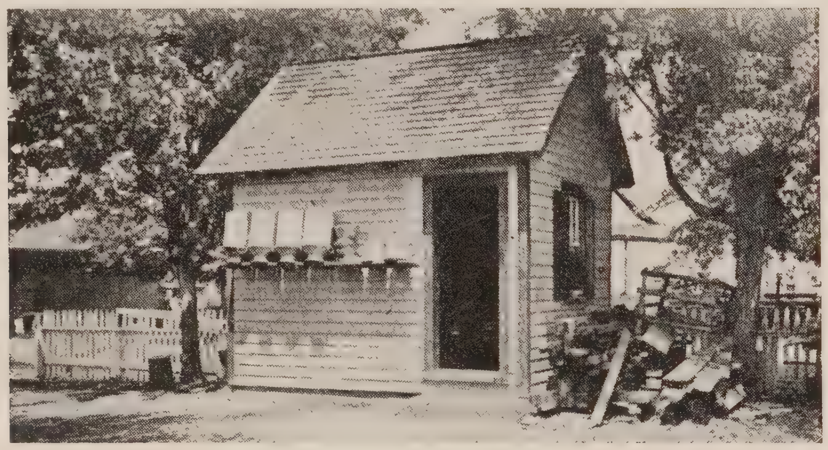
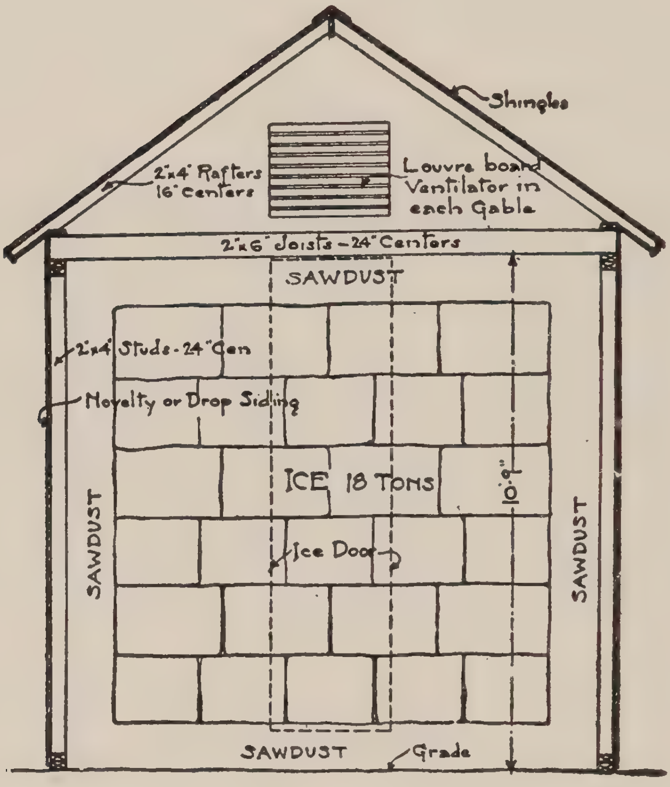


FIG. 99.—Inexpensive milk house.

The insulated ice house is one in which the packing is put in the walls rather than upon the ice itself. The ice is packed clean and close to the walls where it will keep even more perfectly than when packed in the ordinary sawdust fashion. Many of the best, moderate-sized creameries are now employing this system and it is certainly to be recommended to the larger class of farm dairies. The milk house and the ice house may be built under one roof which will reduce the labor of use to the minimum. See the plan already given of this type of combination milk and ice house.

QUESTIONS

1. What are the essentials of a farm milk house?
2. Where should it be located?
3. Of what material should the floor and lower walls be made?
4. How much ice is required per season of six months per cow in the northern half of the United States?
5. What is an "insulated" ice house?
6. How may an insulated ice house and a milk house be economically combined?
7. What does one cubic foot of water weigh?
8. What does one cubic foot of ice weigh?
9. How many cubic feet will one ton of solid ice occupy?
10. How many cubic feet should be allowed for each ton of ice to be used?



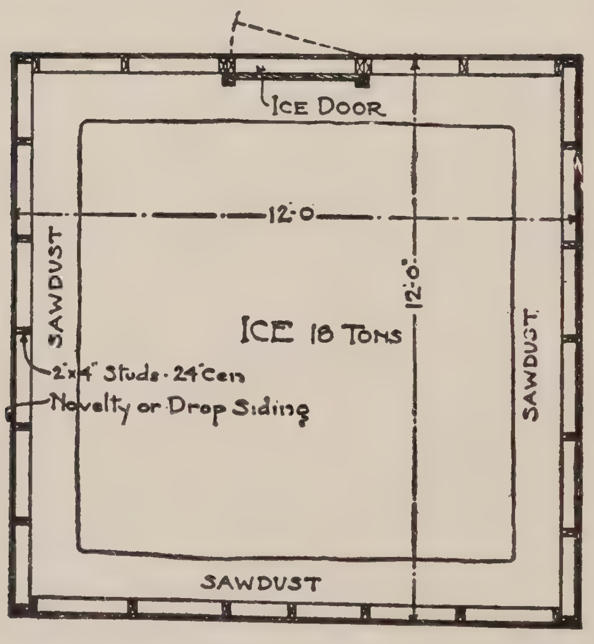


FIG. 100.—Ice house, old style. Ice covered over and around with saw dust. Reproduced from "Practical Cold Storage," by Madison Cooper. (Published by Nickerson and Collins Co., Chicago.)

CHAPTER XXVIII

MILK AND CREAM TESTING

To produce milk or butter fat for market most economically and profitably it is nearly, if not quite, as important that the grade of milk be known as it is to know the quantity yielded. Milk testing 7 per cent fat has nearly twice the food value of one testing 3 per cent fat, and likewise requires nearly twice as much feed to produce it (Chapter XXIII). There never was a time when the dairy farmers needed to feed scientifically more than at present, nor a time when this could more easily be done.

The dairy farmer should own a milk tester and use it, chiefly because of its aid in economical feeding. A second reason why the tester on the farm is needed is that by its means the unprofitable cows may more promptly and accurately be singled out for disposal. The man who sells to the city should be careful never to allow milk to go to market which is below the legal standard in fat. Whether cream is shipped or drawn to local market the thoroughness of skimming done by the separator on the farm should, from time to time, be determined. It is also convenient frequently to use the hand tester to check the accuracy of the cream testing done in the city or in the local creamery.

Easy to Learn.—The process of testing milk by the Babcock method is not difficult to learn, nor to perform. Any bright boy or girl of fifteen can readily learn to do very satisfactory work, especially if shown once or twice how to do a few of the more particular pieces of work.

Does Not Take Long.—The total time required to make a single test of milk need not be more than fifteen minutes; two samples can be tested nearly as quickly as one; a dozen samples can be tested in half an hour. Testing milk makes a good "rainy day job" and may be worth more than the work which could be accomplished ordinarily during the same length of time.

Equipment Needed and Cost.—A testing machine such as shown in figure 109 may be obtained complete with glassware for operation at from five to six dollars, but such machines are

not to be recommended. The reasons for not favoring such are: (1) The small capacity prolongs the time required to do a moderate amount of work and greatly increases the likelihood that the testing of the herd will not often be undertaken. (2) The bottles are so thoroughly exposed to the air that unless the bottle pockets are filled with hot water the contents cool too rapidly to permit either of thorough testing or accurate reading. (3) Test bottles do occasionally break, and if such an accident should occur in an open machine the chances are great that it would at least cost the suit of clothes worn, and possibly cause greater damage.

A machine like that shown in figure 101 with a capacity of eight to twelve bottles, enclosed with close-fitting cast-iron frame, costs only ten to twelve dollars, with glassware complete. It protects the sample from being cooled in the air; protects the operator from accident, and increases the likelihood of a good test.

The glassware needed for the larger machine, constituting one set, will consist of a dozen whole milk test bottles; two or more skim milk test bottles, and preferably, two cream test bottles, two pipettes, graduated to 17.6 c.c.; one pair needle-point dividers; and a few ordinary dishes for the pouring of milk, and the handling of hot water. See figures 101, 102, 103, and 104, for illustration of the various tools needed.

Since glassware is liable to be broken and is not usually carried in stock in villages, it is highly desirable that there be procured at least two pipettes and acid measures, and a reasonable stock of test bottles. Pipettes may be used to measure the acid, but it is hard on the throat on account of the acid fumes.

Properties of Milk.—Milk is a mixture of water in which is dissolved a considerable quantity of milk sugar and a small quantity of albumen, with casein, which is the chief substance of which cheese is made, present in a fine suspension, and butter fat which is present in the form of an infinite number of small round globules. The composition of milk differs greatly between breeds and individuals of the same breed.

Although the protein (casein and albumen) and the ash are far more important in the growing of calves, pigs and poultry

on the farm, the fat is commercially the most valuable. Fat is also the element in which there is the greatest variation. Being so variable in amount and so valuable on the market, it becomes highly important that a test made shall be accurately done.

Procuring the Sample.—If the milk of a single cow is to be tested she must be milked dry and the milk thoroughly stirred, preferably by pouring from one pail to another before a sample is taken. This is necessary because the last milk, or strippings, is anywhere from two to eight times as rich as the first milk

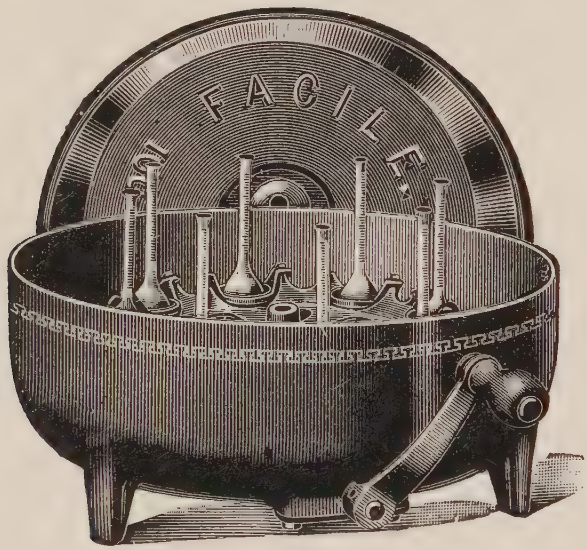


FIG. 101.—Eight-bottle hand tester. Farm size.

drawn. Merely drawing the milk into the bottle will not suffice for the securing of an accurate sample.

If a can or vat of milk is to be tested it must be very thoroughly stirred before the sample is taken. Fat will rise in five minutes sufficiently to show variation between the top and bottom of a pail or can of milk. So small an amount of milk as a single ten gallon canful will contain over 37,000 cubic centimeters. In testing we use only 17.6 c.c., which is only one part in 2162 parts of the whole. Where so small a quantity is used to determine the value of so large a mass it is extremely important, indeed, that the small amount be carefully taken.

Making the Test: Drawing Sample.—With test bottle placed conveniently and safely and with pipette near at hand, mix again the sample of milk by pouring from one cup or dish to another, taking care that the milk flows down the side of the

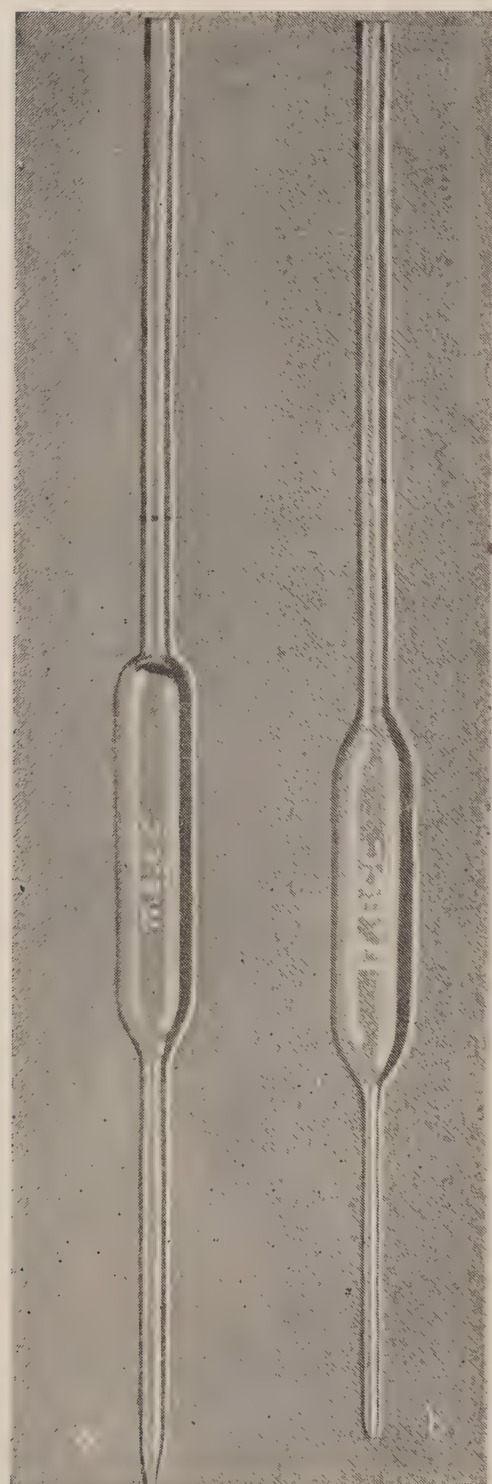


FIG. 102.—Milk pipettes. *a* has a thick clumsy tip which will not enter a standard 8 per cent milk test bottle. *b* is very much more serviceable.

dish, rather than pouring into the center. This would introduce air bubbles and cause inaccuracy. Note the ring of cream

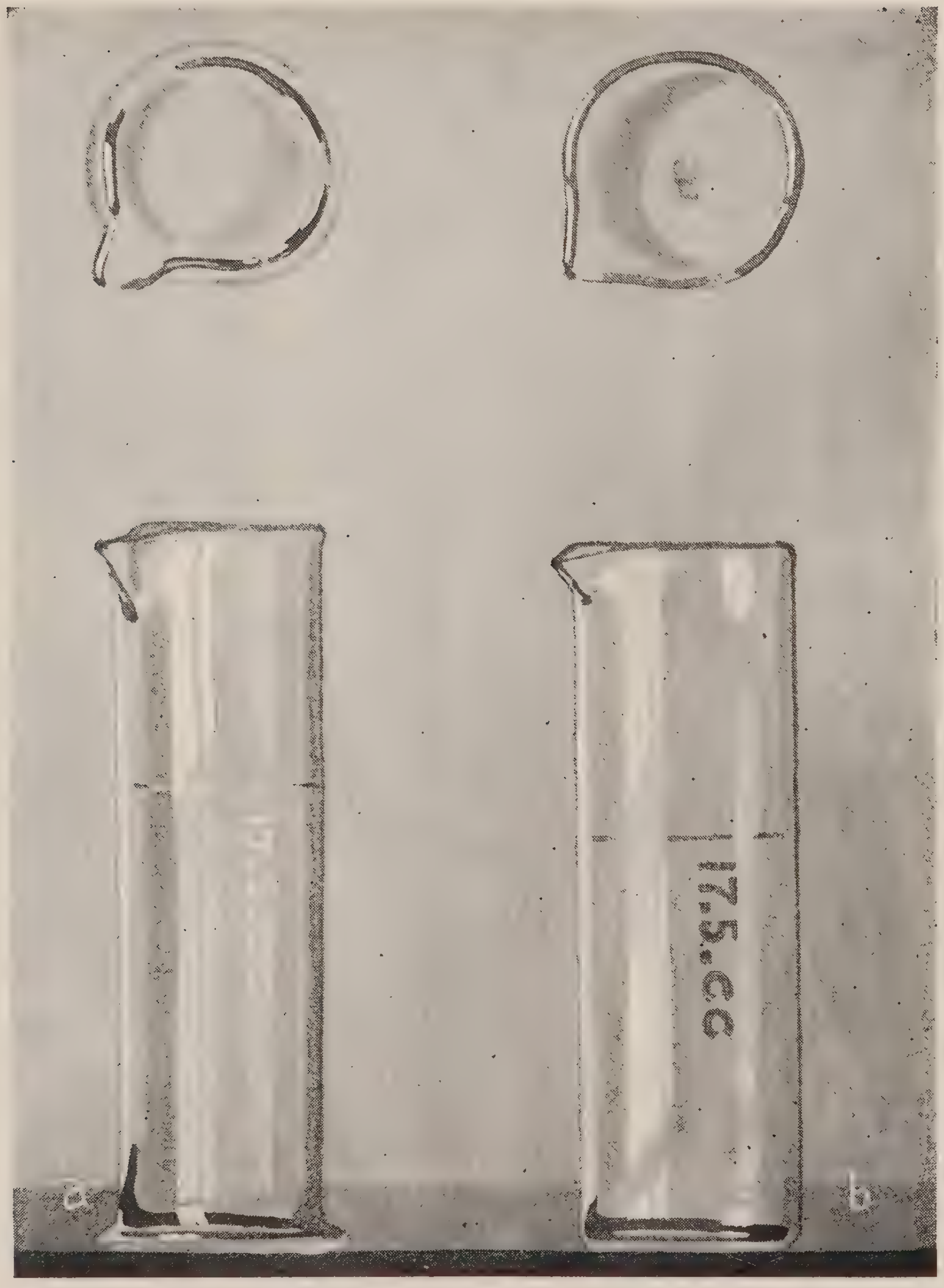


FIG. 103.—Acid measures. *a* is preferable to *b* on account of the flaring base, which renders it less liable to tip over, and the lip out of which the acid is poured is not so wide from side to side, thus easier to pour from without spilling.

on the side of the container. This should be carefully rinsed off by the rotary motion of the milk. With pipette grasped firmly in the hand, as shown in figure 105, with thumb and two fingers serving to hold the instrument; little finger acting as guide, and fore finger to be used as a valve, draw the milk into the pipette,

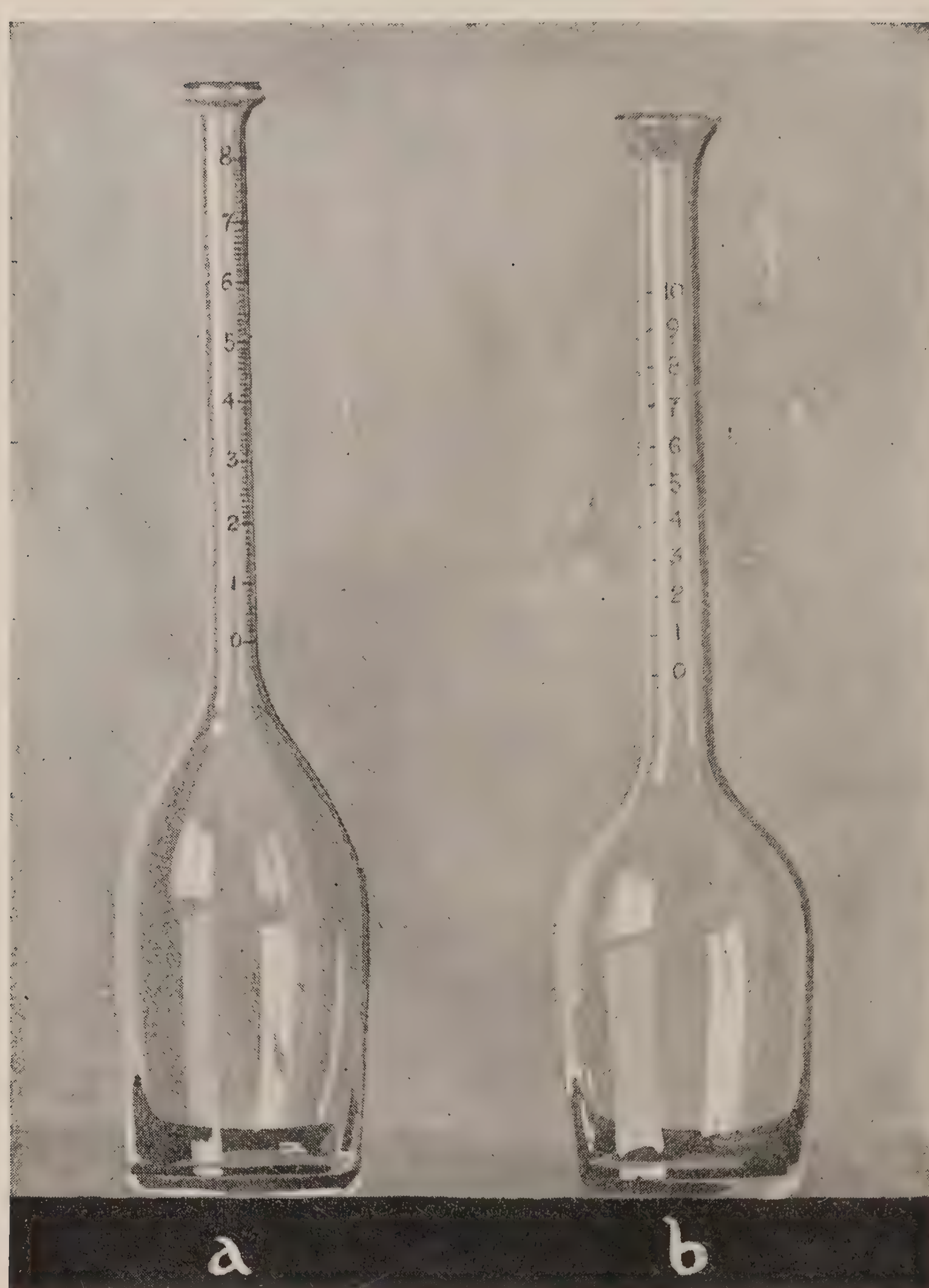


Fig. 104.—Milk test bottles. ***a*** is very much preferable to ***b***. First, in having a slender neck, which will permit of accurate reading of the fat; second, in having sloping shoulders. Fat will lodge under the abrupt shoulder of ***b***, and thus reduce the reading; third, the top of ***a*** is not flaring as ***b***. A milk tested in duplicate in two bottles such as these would not read the same.

nearly to the top, slip the fore finger over the top of the tube to prevent air entering. This serves to hold the milk in the pipette. Raise the charge and sample nearly to the level of the

eyes and carefully release the forefinger, allowing air to enter until the milk has descended exactly to the scratch on the stem of the pipette. Again close tightly with the finger and transfer the measured quantity to the test bottle. If the stem of the pipette is sufficiently small, insert into the neck of the test bottle (Fig. 105*b*); if not, hold the bottle and pipette at an angle, as shown at figure 105. This is done to allow the milk to flow

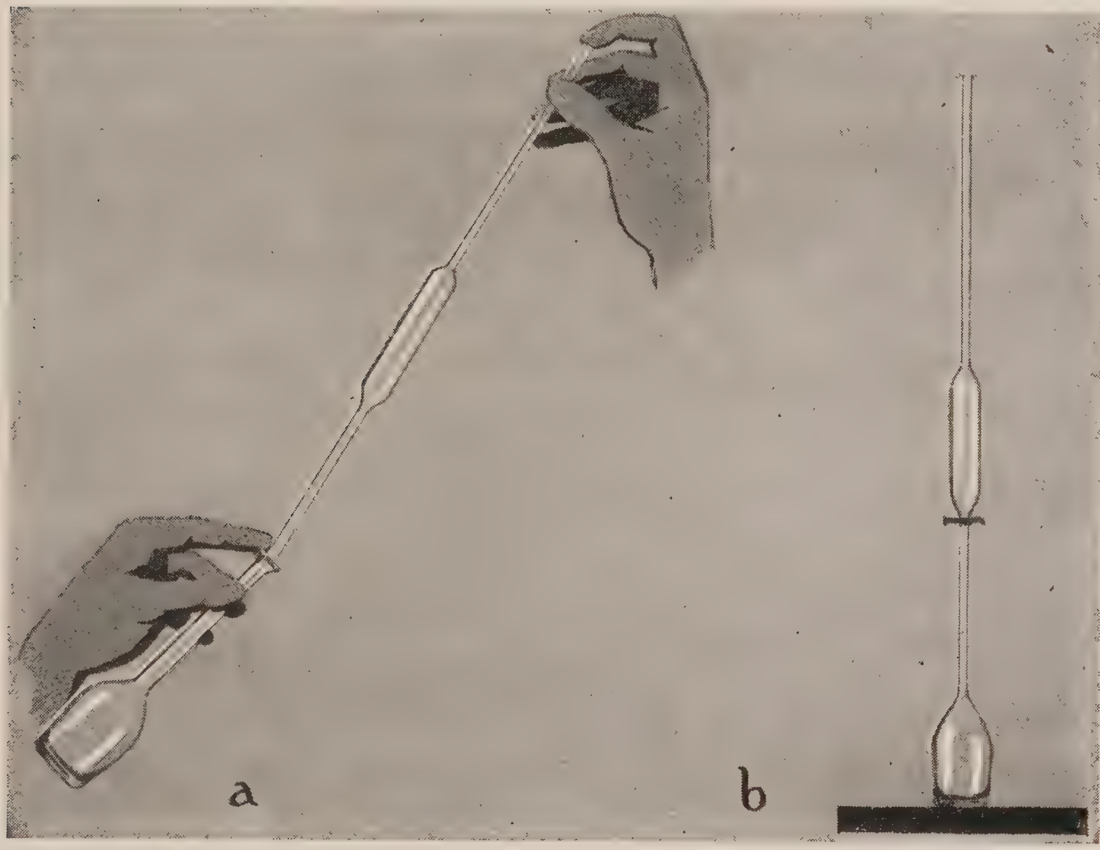


Fig. 105.—Filling milk test bottles. In ***a*** the bottle and pipette are being well handled where it is necessary to hold them while the pipette is being emptied. ***b*** shows a preferable method of emptying the pipette. When the tip of the pipette is slender enough to enter the neck of the bottle, a disc of rubber packing or cork may be slipped on it and the pipette allowed to drain by itself. Two or three such pipettes may be used in rotation.

down the bottom side of the neck of the bottle, while permitting air to escape on the upper side. The last drop of milk should be saved by blowing it into the test bottle.

In testing a number of samples care should be taken to rinse the pipette once by drawing the milk of the next sample to be tested into the pipette and blowing it back; otherwise the quantity of fat which sticks to the inside of the pipette goes from

one test over to the next. In going from a high testing sample to a low testing sample one may easily cause the reading of the low test sample to be one- or even two-tenths per cent too high.

Adding Acid.—Carefully measure out acid (temperature 55 to 65 degrees) into the acid measure. A quantity exactly to the scratch on the little cylinder will be required if the acid is the right strength and temperature, and the milk is not too warm. Warm acid or a warm sample increases the chemical action and will cause a burning of the sample unless checked. If either is too warm use slightly less acid. Pour the acid carefully down the side of the neck, allowing the heavy, half-sticky substance to flow under the milk rather than through it. If poured directly downward into the sample burning and unreliable reading are almost certain to follow.

Mixing Acid and Milk.—By one not especially familiar with the process this mixing should be done immediately after the acid has been added and by all means should be finished quickly when once started. Care should be taken not to shake the sample violently, nor in a perpendicular direction, since this would throw a mass of coagulated milk into the neck of the bottle where it would be forced out by the heat and lost, thus invalidating the whole sample. Shake the sample with an elliptical, rotary motion in such a way as to mix the contents of the bottle without throwing any of it into the neck. Observe the sample for an instant to note the color. Allow it to continue the chemical action till a strong coffee color or deep cherry red has been reached. If the acid is too strong or the ingredients at such a temperature that the mixture at this point begins to turn black, 2 or 3 c.c., a teaspoonful of lukewarm water should be added and then mixed. This checks the action of the acid and prevents charring. Care to get both milk and acid to the favorable temperature will be time well spent, for half the secret of making good tests is in getting the right temperatures.

Whirling.—When all the samples to be tested at one time have been gotten ready in manner just described, the bottles are to be placed in the centrifugal machine, taking care to balance the load in all cases. Increase the speed gradually until the

required force is being developed. Continue even, strong turning for four minutes, when the machine should be permitted to stop of its own accord, or gently retarded by hand.

Adding Water.—Clean, soft water, just below the boiling point in temperature, is to be added, at this point in the process, to each bottle in amount sufficient only to bring the contents up to the bottom of the neck. This enables any curdy matter which may be floating on the heavy acid mixture to settle and not clog the neck.

Second Whirling.—Again the machine is to be strongly turned as before, for three minutes, and then gently stopped.

Finish Adding Water.—At this point more hot water should be added, sufficient to bring the top of the fat column to within about one inch of the top of the bottle, care being taken not to run it over.

Third Whirling.—Again the machine should be run two minutes strongly at full speed. This last whirling is particularly necessary in removing or squeezing the water out of the fat column in the neck of the bottle.

Reading.—Test bottles are graduated to agree with the expansion of the fat when at a temperature of 130 to 140 degrees (Fig. 106). In hand machines there is a constant danger that the fat will be read at so low a temperature that it will not indicate as high a fat percentage as necessary to secure correct results. Furthermore, the fat column should be read from the bottom of the bottom meniscus to the extreme top as indicated in the figure. Although there is a depression, called the meniscus, on the top of the fat column it has been shown that the quantity of fat which would be required to fill this depression is equalled by the amount of fat which regularly remains in the bulb of a good test bottle, and never enters into the fat column. The amount of fat in the column is determined by spreading the dividers from the bottom to the extreme top of the fat column, then by placing the lower point at zero and noting the place indicated by the upper point. The distances between the fine

division on the whole milk bottles have a value of 0.2 per cent (Fig. 111).

Calculating the Fat in Milk.—Assuming that the milk to be tested had been thoroughly stirred before sampling and that the reading on the test bottle shows 4 per cent, how many pounds of fat are there in the total quantity? It must be remembered that the words per cent or the sign % indicates hundredths, therefore in multiplying it is necessary to multiply the percentage figure by one hundred, which will make 4.0 per cent read

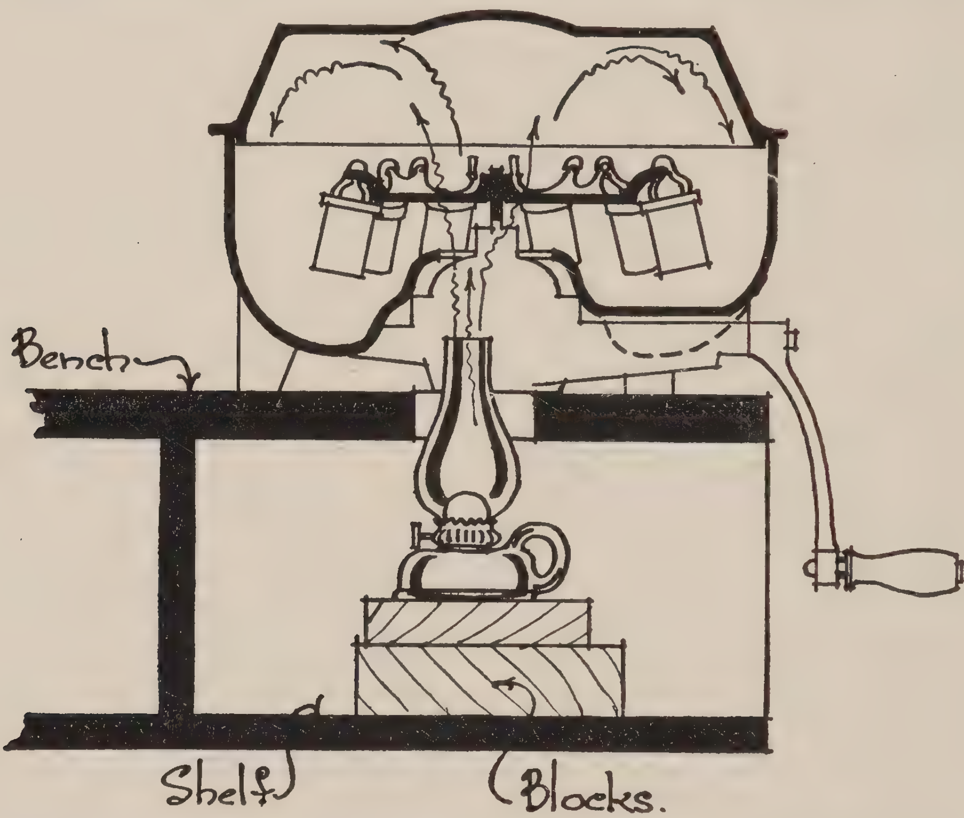


FIG. 106.—The control of temperatures is half the battle in Babcock milk testing. With some makes of testers a common lamp may be used to keep the samples warm. Excellent work can be done even in a cold room with such an attachment.

0.04, and likewise a reading of 3.7 per cent would be written 0.037.

If the cow has yielded 20 pounds of milk which tests 4 per cent fat, there are in that quantity of milk, then, 20 times 0.04, which equals 0.8 pound of fat. Likewise, 40 pounds testing 3 per cent fat contains 1.2 pounds of fat (40 times 0.03 equals 1.2); and 20 pounds of milk testing 6 per cent fat also has in it 1.2 pounds of fat (20 times 0.06 equals 1.2).

A ten-gallon can of milk weighs net about 85 pounds. If it

tests 3.7 per cent the quantity of fat contained would be equal to 85 (pounds of milk) times 0.037 (test) equals 3.145 pounds of fat.

Composite Samples.—A composite sample is one made up of a number of smaller samples. If a small quantity of the milk yielded by a cow morning and night for a week be added to a glass jar and adequately preserved, a single testing of the composite sample at the end of the week will indicate the average quality of milk produced by that cow throughout the week, provided the quantity of sample taken is in proportion to the amount of milk given. This system is employed in whole milk creameries where the milk delivered by each farmer is thoroughly stirred and a small portion added to the test sample, which is held for a period of from one to two weeks, and then tested. This method is convenient and economical of time, but must be operated carefully or expensive errors may be made.

A glass bottle, with large ground-glass stopper (Fig. 107) is by far the most desirable sort of container for the sample. The two points to be guarded in the holding of the sample are: First, the prevention of evaporation and, second, the prevention of the loss of fat due to its sticking in the crevices of a rough cover. A sample kept even half a day in an open dish like a tea cup is utterly worthless as a means of determining the fat content of the milk produced or delivered, since so large a quantity of water would have evaporated that the remaining portion would be too rich in fat. For the same reason, but to a less degree, a bottle with a large cork stopper is not to be recommended, some water would escape through and some fat would cling to the cork. Mason fruit jars have often been used. These prevent evaporation, but cause more or less loss of fat about the top. For ordinary farm use they probably will serve as well as anything to be found. In the earlier days of creamery work, and to some extent up to the present, pint milk bottles with metal caps which clamp more or less tightly were employed. It has been shown by trial that the amount of water which will evaporate from such a lid is very appreciable, indeed, and that many creameries are paying for more fat than they actually receive on this account. This reduces the percentage over-run on the part of the

butter maker and occasionally encourages him to record a test lower than the actual reading, to recover in the operation.

If a cow is being tested and she yields 30 pounds of milk for thirty days, she has produced 900 pounds of milk. If this is shown to test 3.9 per cent fat, she will then be given credit with having produced 35.1 pounds of fat, whereas a glass-stoppered bottle which would prevent evaporation of water might show her true test to have been 3.6 per cent fat. This would credit her with having produced only 32.3 pounds of butter fat, or a difference of 2.8 pounds of fat. If the fat is figured as worth 30 cents per pound the cow has been given credit with hav-

Fig. 107.—Composite milk sample bottles. Evaporation of moisture must be prevented. The bottle at the right is preferable to the fruit jar.

ing produced 84 cents' worth of product in one month more than she is entitled to. At this rate each cow in the herd would have been given credit during the year with having produced from $5 to $10 worth of product more than was rightly her due. The money value difference between a true test and one made too high by the evaporation of water from the sample is better shown in the case of the whole milk creameries. If a farmer have twelve cows averaging 25 pounds of milk each, or 300 pounds of milk per day, they will in fifteen days produce 4500 pounds of milk. With the fat percentage in error as above mentioned, the farmer will be given credit for having delivered 13.5 pounds of fat in the 15 days, more than he had actually delivered. If

the fat is worth 30 cents a pound it would amount to $4.05, or approximately $8 a month. If there are 75 such patrons, $600 per month may easily have been paid out to the farmers for milk fat which was never delivered. This is one reason why some creameries have great difficulty in maintaining an adequate or even reasonable over-run. The sample must not only have been thoroughly taken, but also have been protected from evaporation of water or mechanical loss of fat in order to be of exact value.

Preservatives for Samples.—In order that it shall not be necessary to test the milk immediately nor to test every milking, preservatives have been brought into use for the purpose of keeping the milk sweet. All milk preservatives are poisonous, otherwise they would not destroy the bacteria and preserve the milk. The best preserving substance to use is corrosive sublimate, made up in tablet form, with the addition of coloring matter. The preservative itself is colorless. The coloring matter is added to insure safety. Tablets of this sort may be procured from any of the dealers in creamery supplies.

Potassium bichromate in powdered form is absolutely not to be recommended for general use. It unites with and increases the strength and action of the acid and since it is extremely difficult to measure the powder with sufficient accuracy to get exactly the same quantity into each sample bottle, the tester will later be unable to know how much acid to add to secure the desired effect. This substance is now put up in tablet form, which increases the ease with which it may be used and makes of it a fairly satisfactory preservative. Care must be exercised, however, in the addition of the acid to the sample that a quantity less than usual is added, and that there is near at hand some warm water to be added if necessary to check the burning process.

Formaldehyde is the safest of all the preservatives to use, since it gives off a violent and disagreeable odor, and therefore is not likely to be consumed, and not being a violent poison would not likely cause disastrous results if it were accidentally fed to pigs or calves. The chief objection to its use is the fact that it seems to toughen the casein in the milk and render the thorough digestion by the acid difficult. It is necessary to use more

acid and to shake more thoroughly when this preservative is used.

In all cases, regardless of what preservative has been used, the operator should use the color of his test as his guide and not merely the usual amount of acid.

Sampling Sour Milk.—Not infrequently milk will have become sour and thick before the operator has had opportunity to make a fat determination. To reduce such a mass to a fluid requires the presence of some alkali to neutralize the acid. For this purpose ammonia is occasionally used, though a few grains of concentrated lye dissolved in a very small quantity of water may be employed without harm. Various washing powders such as sal soda may also be used. These strong alkalies neutralize the acid and render it easy for the whole curd mass to be shaken into a thoroughly fluid condition. Care must be taken, however, in shaking not to churn the sample, since, under these conditions the fat particles will assemble into masses very easily. The acid should be added slowly and cautiously to any sample which has been neutralized, otherwise the sample may foam badly and even boil out on the hand. It is advisable also to make the test, at least in duplicate, to insure accuracy.

Sampling Churned Milk.—Occasionally a sample of milk will be sent by mail and upon arrival found to have been churned during transit. To obtain a correct sample of such the entire quantity should be heated to 110 degrees and held until the fat has melted, when again the entire amount should be violently shaken sufficiently long to form an emulsion of all the ingredients present. The fat particles, however, will still be very large compared to their size in the original condition, and will therefore rise quickly. The test sample may preferably be pipetted out of the stream while pouring the emulsified sample from one dish to another. To be reasonably sure that a correct test has been made at least four samples should be run, the entire quantity being kept warm and shaken between each sampling. If, after such treatment, the four samples show a close agreement the average may be taken as the probable true test of the sample.

Sampling Frozen Milk.—When milk freezes the watery portion crystallizes into spines and bars of ice, with a tendency

to throw down all substances in suspension. An application of this principle is seen in the freezing of a shallow muddy pond or lake. The ice will be far cleaner than the water was before the freezing started. The dirt will have concentrated downward. When a quantity of milk freezes the solid particles are concentrated largely into the center, the outer portion being more largely the water part of the milk. The effect of such is the partial formation of the curd into flakes. These floating particles interfere considerably with the taking of an accurate sample. To obtain a true sample it may even be necessary to weigh out 18 grams of the thoroughly warmed and poured sample into the test bottle rather than to measure it with a pipette.

Testing Cream: Sampling (Figs. 108 and 109).—Cream varies so greatly in fat content and in its fluid properties and mixes with such difficulty compared with milk that much greater care is required to be exercised in obtaining an accurate sample. Cream will rise on cream to such an extent that the top of a can may test 35 per cent fat while the bottom contains only 10 or even 5 per cent fat. In order to obtain a sample which is at all adequate in determining its value, it is essential that the cream be either thoroughly stirred from the bottom by means of a stirring device consisting of an iron rod fitted with a strong disc at the lower end and by means of which an upward rotary motion in the cream can be effected; or by pouring the cream several times from one can to another. When the cream is thoroughly mixed, a quantity of two to three ounces may be transferred to the sample bottle for future work.

Composite Samples.—Although sufficiently accurate work may readily be done from composite samples of milk the system is not to be recommended for cream. This is chiefly due to the great variation in fat content of the cream, and also to the varying amount which is usually taken to market.

Necessity for Weighing Cream.—The Babcock test is based upon the use of eighteen grams of sample or some known fraction thereof. Since butter fat weighs only about 87 per cent as much as milk serum and since the fat content of cream will vary all the way from 12 to 50 per cent it is evident that with the various

grades different volumes of cream would be required to weigh 18 grams. A pipette graduated to carry 17.6 c.c. will carry 18 grams of ordinary milk, but the cream which would be contained

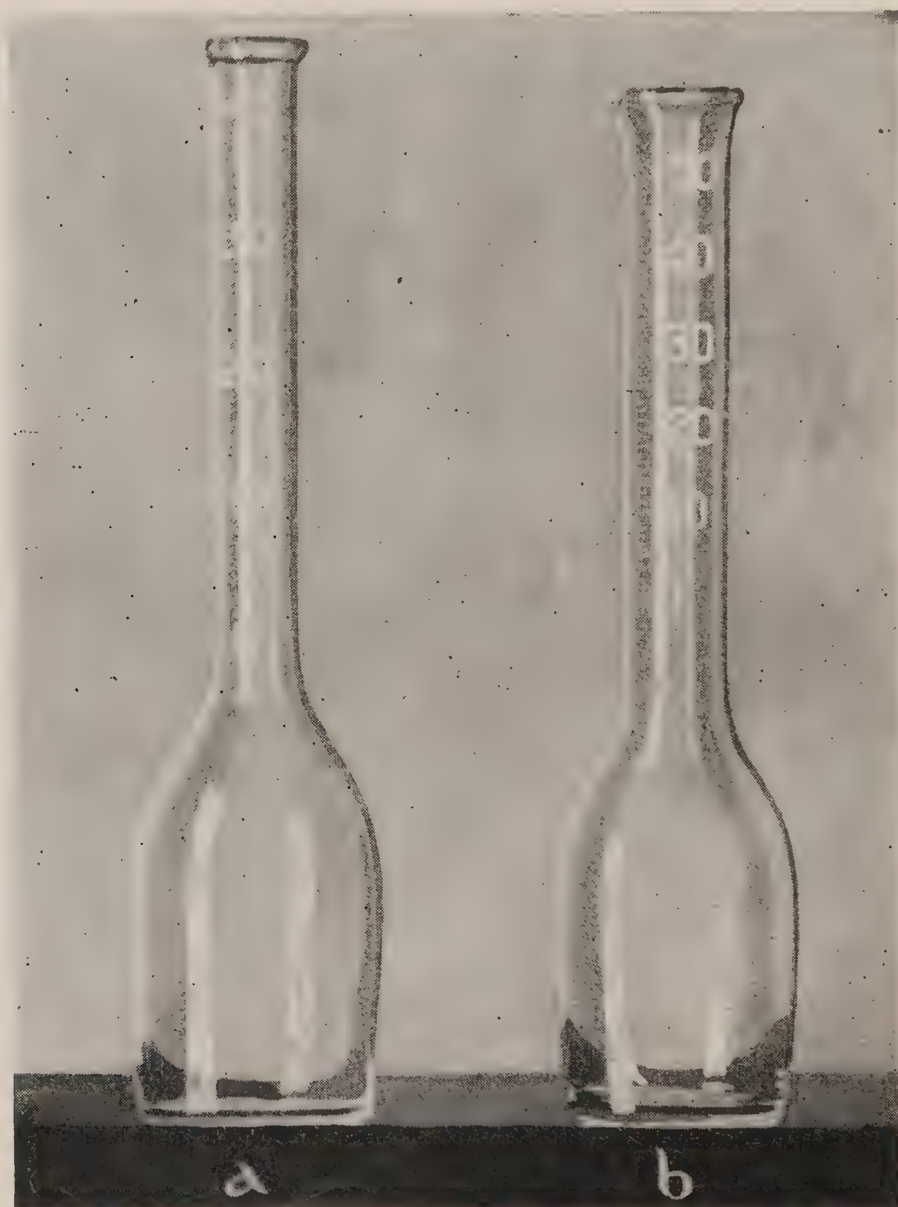


FIG. 108.—Cream test bottles. ***a*** is preferable to ***b*** in three points. The narrower neck permits more accurate reading of the fat, the neck is straight, *i.e.*, not flaring toward the top, and the shoulders are more sloping.

in that volume would weigh only 15 to 16.5 grams, depending on its richness. It is therefore essential that cream be weighed into the test bottles and not measured as in the case of whole and skim milk.

Another reason why it is essential to weigh cream is the presence in the cream of larger or smaller quantities of gas. Naturally any cream which has been poured or stirred until it contains a considerable amount of air or other gas will occupy more volume for its weight than it would if it had not been so treated.

The kind of scales to be recommended will vary with the volume of work to be done. The finely adjusted Torsion balance designed to accommodate two to four bottles at a time is exceedingly sensitive and valuable when high-class work is to be done.

Weighing Out Samples.—It is sometimes necessary to warm the bottle of cream to make the cream flow more readily. A

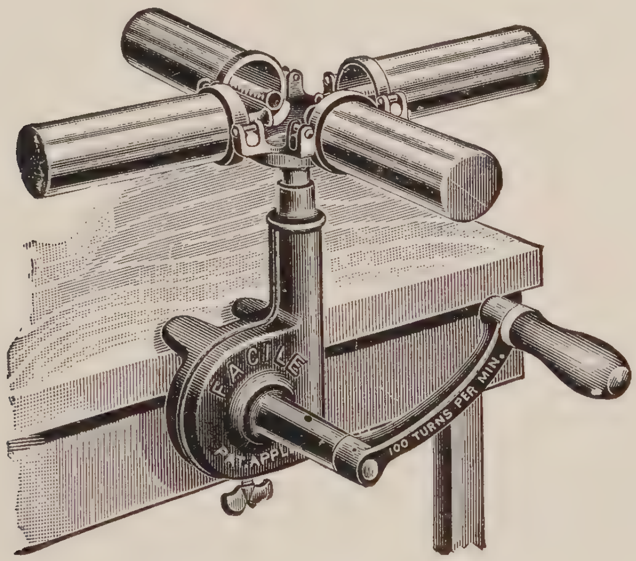


Fig. 109.—An inexpensive tester, yet one not to recommend for general farm use. The samples cool too quickly in this and if a bottle were to break, the acid would be liable to do injury.

quantity of cream may then be drawn into the pipette and allowed to flow into the test bottle on the scale, care being taken that a quantity be added sufficient only to bring about an exact balance. In doing this, care should also be taken that no drop of cream falls upon the outside of the bottle or upon the platform of the scale. When the sample has been weighed out it may be set aside to be tested at any future time. The water only can evaporate. It is best, however, to run out the samples while they are still fresh.

Instead of using 18 grams as indicated, nearly, if not quite, as accurate work can be done by adding only 9 grams of sample and then by doubling the reading secured. This is economical of both cream and acid.

Adding Acid.—If 18 grams of cream are taken as sample somewhat less than the usual measure of acid will be required. If a 9-gram sample of cream is taken then less than half the usual measure of acid will be needed. This is due to the fact that so much of the sample is fat that there is not as much solids to be dissolved as in the case of whole milk. The test bottle should be canted so that the acid may flow down the side of the neck as in the case of milk. Likewise it is preferable to mix them thoroughly immediately upon the addition of the acid. At this point it is necessary also to watch carefully the color of the sample (Fig. 110). The reddish color soon changes to a dark cherry-red, and may assume almost a black hue. The sample must not be permitted to become fully black, for if this has taken place considerable charring has been caused. To prevent burning at this point, about half a teaspoonful of lukewarm water should be added and shaken into the sample. This small amount of water "kills" the acid.

First Whirling.—As in the case of milk the test bottles should be so placed in the machine as to balance. They are then turned rapidly according to the size of the machine (Fig. 109), for fully five minutes, when the machine is gently stopped or allowed to come to rest of its own accord.

Adding Water.—Clean, soft water at a temperature of about 190 or 200 degrees may now be added. This is done simply for the purpose of bringing the fat up into the neck of the bottle where it can be read. In case of rich cream it may be necessary to fill the bottle nearly to the top, otherwise, leaving a safety space of about an inch unfilled. A single filling is found to be sufficient in the case of cream, since the work cannot be carried on with the same degree of accuracy as with milk in any case.

Second Whirling.—This second whirling should be done strongly for fully four minutes to insure the ascension of all

A B

FIG. 110—A, CREAM TEST, AND B, MILK TEST. PERFECT COLOR FOR PERFECT WORK.

the fat into the neck, and also to insure separating the water from the column of fat.

The Use of a "Reader."—It will be noted, as shown in figure 110, that the depression or concave portion on the top of the fat column, in the case of cream, amounts to considerable. The quantity of fat which would be necessary to fill up this concave area, or meniscus, is altogether greater than the amount of fat which remains in the bulb of the bottle; consequently allowance must be made for the depression. Or better still, some substance like amyl alcohol, colored red with some dye, or a lightweight machine oil, as glymol, may be added to flatten the surface. It has been the experience of the writer that the oil obtainable varies considerably in weight and is less reliable than the alcohol. The substance usually sold by creamery supply companies is mostly amyl alcohol colored with a dye.

Reading the Sample.—The reading is done the same as in the case of the milk. It is a little more important, however, that a temperature of at least 130 to 140 degrees be maintained, since the fat column is so long. The reading should be made from the extreme bottom to the flat surface shown between the red reader and the fat, or in the case no "reader" is used the upper part of the dividers should be made to divide the distance occupied by the meniscus about equally (Fig. 111).

It is impossible to test cream to the same point of accuracy as that reached in the case of milk. This is due to the wide neck in the bottle which it is necessary to use. Therefore it is found that a variation of one-half per cent in duplicate samples of sour cream is not at all uncommon and would almost be expected.

Calculating the Fat in Cream.—A ten-gallon can will hold about 84 pounds of ordinary cream. If this is shown to test 34.5 per cent, the quantity of fat in the can is found by multiplying 84 by 0.345; thus 84 times 0.345 equals 28.98 pounds of fat. An eight-gallon can will hold about 67 pounds of ordinary cream. If the test shows this to contain say 26.5 per cent fat there will be contained in it a quantity of fat found by multiplying 64 by 0.265, or 17.80 pounds of fat.

True Average Test of Cream.—The chief reason why it is

difficult and unsatisfactory to try to carry on composite samples of cream for the purpose of knowing the pounds of fat delivered, by means of a single test, is because the test of the several lots varies so greatly that unless a sample be taken in exact proportion to the quantity of cream delivered, or received, the effect of this method of delivery upon the sample will be out of proportion. To illustrate, suppose there be delivered to the factory, four batches of cream as follows:

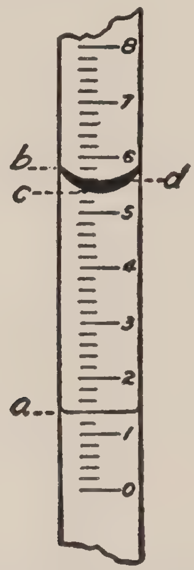


FIG. 111.—In milk testing the fat should be read from ***a*** to ***b***, not to ***c*** nor to ***d***, but in cream from ***a*** to ***d***.

Lb. Cream	Test	Lb. Fat
20	30	6.0
180	25	45.0
70	40	28.0
220	22	48.4
490	117	127.4

The false average test, found by dividing 117 by 4, is 29.25 per cent.

The average test, found by dividing 117 by 4, is 29.25 per cent. There will have been delivered 490 pounds of cream. The quantity of fat delivered may readily be found by multiplying the pounds of cream by the test in each and every case, and by adding the quantities of fat. Thus we see in this case 127.4 pounds of fat were delivered. If a composite sample had been made of these four lots of cream and the quantity of cream taken for the sample had been the same in each case the test of the

composite sample would show the same as the direct average of these four, or 29.25 per cent. That this test is too high is readily seen when we divide the actual quantity of fat 127.4 by the quantity of cream, 490. Performing this we see that the true average test, instead of being 29.25 per cent is only 26 per cent. The direct or false average, therefore, is 3.25 per cent too high. An error of this magnitude operating upon 490 pounds of cream throws an error of 15.925 pounds of fat. If fat is being bought at the rate of 30 cents per pound an over-payment of $4.78 has occurred (490 times 0.0325 equals 15.925; 15.925 times 30 equals $4.78). It is evident, therefore, that any butter maker who makes composite samples of cream delivered by his patrons is almost certain to make errors of this sort. While in the long run and on the various patrons there may be a balance or compensation it certainly is an inaccurate and unreliable method of computation. Likewise, a farmer, in endeavoring to check up the accuracy and honesty of the creamery operatives, is more likely than not to make an error of this kind, either one way or the other, if he tries to make composite tests. Each and every can or shipment of cream should be weighed, sampled, and tested by itself. It should be remarked in passing that this is the practice with the larger and better-conducted creamery plants.

Testing Skim Milk.—Skim milk is tested in the same manner as whole milk, except that the skim milk bottle is used. The essential difference between the skim milk bottle and the whole milk bottle is in the size of the tube or bore of the neck. At present most skim milk bottles are so made that the entire length of the graduated scale equals one-fourth of one per cent (0.25 per cent), and each of the five grand divisions of the scale has a value of five one-hundredths per cent (0.05 per cent). In testing skim milk care must be taken to make sure that no drop of water or other plug remains in the graduated neck at the time of pouring the milk, or the acid, into the bottle. A drop of water lodged in the neck, very frequently, indeed will cause the air to bubble back against the acid or milk while being poured down the large neck, causing same to spill. If any portion of the sample is wasted, the whole is lost.

Skim milk has more solids not fat, for the acid to digest, thus about 20 c.c. acid are needed for 17.6 c.c. of skim milk. A little greater care should also be taken in mixing the acid with the milk. All other steps are the same as with whole milk.

Ordinary gravity skim milk usually tests at least 0.1 per cent and frequently 0.50 per cent. The centrifugal cream separator, properly adjusted, will leave in the skim milk a quantity of fat so small as to read 0.02 per cent or less.

If 100 pounds of milk testing 4 per cent fat is run through a separator there will ordinarily be produced 20 pounds of 20 per cent cream. This leaves 80 pounds of skim milk. If this is found to contain 0.03 per cent fat there will remain in the 80 pounds only 0.024 pound of fat (80 times 0.0003 equals 0.024). There is at present no excuse for a fat loss represented by even so small amount as 0.05 per cent.

Testing Buttermilk.—So far as the testing of buttermilk is concerned it is usually very simple, indeed, provided an accurate sample can be taken. The difficulty in getting a sample is experienced because the grains of butter are so large that to include one in the sample will manifestly give altogether too high a reading, while to avoid all will yield a fat reading evidently too low.

If the cream has been properly ripened and has been churned cold there will usually be an invisible fat loss of about 0.05 per cent, though 0.1 per cent is not as uncommon as it should be. It is not always easy to know in advance whether to put the sample into a skim milk bottle or into a whole milk bottle. Not infrequently one of each is used in order that one or the other shall be readable.

Testing Whey.—Whey obtained in the making of cheese contains little more than one-half of the solid matter contained in skim milk of the kind which is attacked by the acid. The sugar and the albumen only remain in appreciable amounts. Since the work to be done by the test acid is only about half as great as in the case of whole milk the quantity of acid to be used in testing is only about one-half as great.

Bottles are on the market made expressly for the testing of whey. They differ from the ordinary whole milk bottle only in having a bulb sufficiently large to contain two charges of whey

and one of acid. The graduated neck is also only about half as long as in the case of whole milk. The fat test obtained is then divided by two, since twice the 18 grams of sample had been taken. Whey may be tested, however, in the ordinary whole milk bottles with fair accuracy by using 17.6 c.c. of sample and about one-half the usual charge of acid.

Some fat is always lost in cheese making, that is, lost to the cheese. At present this is frequently recovered by the separation of the whey by means of a cream separator, modified for the purpose. The fat then is made up into "whey butter." Whey should not test more than one-fourth of one per cent (0.25 per cent), though 0.3 per cent is a rather more common loss.

Testing Cheese.—Ordinary cheese may be tested for fat by means of the Babcock method. This is best accomplished by securing a representative sample of the cheese in question by trimming off the outside, dryer portion, using only the uniformly moist center. This may then be cut into fine bits, on paper, and nine grams weighed out as in cream testing. To the bottle containing the crumbs of cheese about six c.c. of hot water should be added. The whole mass is then stirred or shaken until warmed throughout and softened. Ordinary testing acid is then added, little by little, mixing and watching for color until the right shade has been reached. A little more lukewarm water should then be added to check further charring. The sample then is run out the same as cream or milk. The amount of fat will be found by doubling the reading obtained, since only nine, instead of eighteen grams of sample were used.

The Centrifuge: Kind.—There are several milk-testing machines on the market that have proven themselves thoroughly serviceable. Aside from favoring the heavier and enclosed machine already indicated the writer has no particular choice, provided the machine is to be used in a warm room. If, however, the testing outfit is to be placed in the ordinary milk room where the air is often cold, a machine provided with an opening below, through which or into which the chimney of a small kerosene lamp can be inserted is preferable to the machine tightly closed below. It is essential that the samples be kept thoroughly warm, even hot, not only at the time of reading the fat, but dur-

ing the whirling process. Hot water in the machine is a nuisance and does very little good. On the other hand, a little kerosene stove arranged under the tester as shown in figure 106, has been found to give excellent results, regardless of the temperature of the work-room.

Size.—A tester which will hold at least 8 bottles, or in case of a herd of 15 or 20 cows, 12 bottles will be found preferable to anything smaller. The slight increase in cost will be readily made up by the increased rate with which the work is done.

Speed.—The number of revolutions required to produce the required force in the machine varies with its diameter. The following table shows the number of revolutions needed for machines when the revolving portion has the diameter indicated.[1]

Diameter of Wheel	No. revolutions per minute
10	1074
12	980
14	909
16	848
18	800
20	759
22	724
24	693

Longer turning with lower speed will not produce the effect of high speed. It will neither force the small fat globules out of the bulb of the test bottle into the neck, nor will it squeeze the water out of the fat, back into the lower portion of the bottle as will be done with high speed. It is essential, therefore, that the machines be placed on a thoroughly sound foundation and set level and run at full speed.

Temperature.—So necessary is it to have a reasonably warm temperature in the machine that the power or factory-size machines are usually provided with a direct steam inlet. Samples may then be warmed before or during the whirling and kept hot until the fat percentages have been read. With the hand machine the same effect can be obtained by having a lamp placed as previously described (Fig. 106).

Care of the Machine.—It may be almost useless to state that

[1] Testing Milk and its Products, Farrington and Woll.

this machine, like any other, requires being kept well oiled. Too liberal oiling while in motion, however, may cause particles of fat to be thrown into the tops of the test bottles, thus introducing a very appreciable error.

In case of an accident causing acid to be spilled inside of the iron frame, it is very unwise indeed, to allow it to remain. All broken glass and every vestige of acid should be cleaned out immediately and thoroughly, otherwise the acid will continue slowly to act upon the iron, releasing fine dust-like particles very disagreeable to breathe. The machine also, it may be known, will be rusted or corroded out rapidly under such conditions.

Acid: Kind.—The acid used in the Babcock test is the commercial sulfuric. The commercial quality is much cheaper indeed, than the pure, yet its impurities do not introduce any error in the test. In case it becomes necessary to procure testing acid from, or through a drug store, it is wise to insist, not only on sulfuric acid, but for the commercial grade. Pure acid, in addition to being far more expensive than is needed, is altogether too strong to be used with comfort or safety.

Strength of Acid.—Commercial sulfuric acid has a specific gravity of about 1.82, or in other words, is 1.82 times as heavy as water. Pure acid is heavier. The commercial grade is often spoken of as 90 per cent strength. Thus in purchasing, the buyer has amply described the article wanted by calling for commercial sulfuric, specific gravity 1.82 or 90 per cent strength.

To Determine Strength.—The commercial acid is comparatively cheap and varies in strength, not greatly, but sufficient to interfere with the test made unless a little more or less of the acid is used, according as it is needed. There are simple devices on the market for the purpose of determining the strength of the acid but these are easily broken, and after all, no more reliable than a simple test or trial of the acid in question would be. To test a new quantity of acid, thoroughly mix a sample of sweet milk and load into four bottles and number them. Into bottle No. 1 add three-quarters of the usual quantity of acid; into bottle No. 2, seven-eighths; into bottle No. 3, the usual or ordinary quantity as indicated by the acid measure, and into bottle No. 4, a quantity of acid slightly greater than the amount indicated

with the measure. When these have been run out in the usual manner the quantity of acid used in the test showing up best, will be nearly, if not quite, the quantity thereafter to be used with that particular shipment of acid.

Care of Acid.—Sulfuric acid has a very great affinity for water. If the bottle is left uncorked, moisture will be taken in from the air continually and far more rapidly than one would suspect. Such diluted acid may even have lost its strength to such an extent as to become useless in testing. A rubber plug should be used in preference to one made of cork, though one made of glass is best. If the ordinary cork is used for even a few days, particles of charred substance will be found floating in the acid and will introduce slight, annoying errors in the test made. Neither light, nor heat, nor cold affects the acid, provided it is not used when too hot nor too cold.

Temperature to Use.—Hot or warm acid is far more active than the same when cool. Many samples of milk have been charred from using acid which had stood around the dairy room in summer and used without first being cooled. For best results the milk and the acid should not have a temperature much below 55 nor above 65 degrees F. It is often desirable, therefore, to keep the acid in the basement ice chest, or to set into cold water for a time before using.

Water.—If hard water, that is water containing a considerable quantity of lime, is used there is great likelihood indeed, that chemical reaction following will cause a moss-like mass to be formed in the neck of the bottle through which fat will be distributed. It will be manifestly incorrect to include all of the foreign substance as fat, yet to exclude all of it introduces a yet greater error.

Soft water, that is, rain water or snow water, or better yet, condensed steam will be found most desirable. In case it is impossible to obtain such soft water, ordinary hard water may be treated in such a way as to purify it and yet not introduce an error in the test. This is best done by adding a small quantity of hydrochloric acid to the water. If no hydrochloric acid is obtainable ordinary sulfuric or testing acid may be used instead. One acid measure of acid mixed with half a pint of

water has been found ample to prevent the disturbance due to lime in the water used.

Hot water is necessary to be added to the test bottles. If it is impossible, or exceedingly difficult to get good hot water where needed, any water may be made hot by the addition of a quantity of testing acid equal to about one-quarter of the volume of water used. The acid will make the water hot, yet will not produce any undesirable effects in the test. The writer has often employed this method of securing purified hot water where ordinary hot water could not be obtained.

It is necessary too, for best work, that the water be clean of the ordinary organic impurities, such as would be introduced by using an uncleaned pipette for the addition of the water to the test. Milky water thus added produces a dull gray cloud below or through the fat, and to that extent renders the reading unreliable.

Cleaning Glassware.—The glassware used in testing is not difficult to clean if the washing is done at once, while everything is fresh, but if the milk is allowed to become dry in the pipette, or the residue of the test has been allowed to harden in the test bottle the cleaning process will be many times more difficult.

The first and most important step in the cleaning of the bottles is to empty them while they are still hot and to shake the contents vigorously so that the gray-white sediment noticeable in the bottom of the bottle will be thoroughly removed. The sediment referred to is the milk ash. It is insoluble in water and if permitted to dry and harden in the bottom will be difficult to remove, but may very easily be shaken out while the sample is fresh. All the bottles to be washed should then be rinsed, set upright and into them sprinkled a quantity of strong washing powder. Water as hot as the hands can bear should then be introduced and the neck cleaned inside and out by means of a cylindrical bottle brush made for the purpose. After being thus cleaned all the glassware should be rinsed well with hot water to give the glass a gloss and a clean feel.

Ordinary soap should not be used in the cleaning of such glassware, as the chemical action which takes place with the sulfuric acid and the ingredients of the soap is such as to

form a sticky resinous deposit on the bottles which is hard to remove.

ERRORS TO AVOID IN TESTING

The following are the chief causes of inaccuracy:

1. Gross sample not a true one, because
   - (a) Cream sour and clotted.
   - (b) Cream dried on surface.
   - (c) Cream partly churned.
   - (d) Cream good, but not well mixed before sampling.
2. Test bottle sample not correct because
   - (a) Cream measured instead of weighed. (18 grams required.)
   - (b) Cream weighed with inaccurate scales. (Keep all bearings free from rust and gum.)
   - (c) Of slovenly work in weighing.
3. Acid mistakes—
   - (a) Too much or too strong acid (burns fat).
   - (b) Too little or too weak acid (leaves white curd under the fat).
   - (c) Acid too warm (burns fat: 60 to 65 degrees F. works best).
   - (d) Acid poured through cream (burns in clots).
   - (e) Acid not well mixed when shaking is commenced (burns in clots). (Four or five c.c. lukewarm water will check acid action).
4. Mistakes in whirling.
   - (a) Speed too slow. (Fails to secure all the fat or to dry the fat.)
   - (b) Not turned long enough (5 or 6 minutes necessary).
   - (c) Bottles too cool while turning (fat cannot rise; should be 180 to 200 degrees F.).
5. Mistakes in adding water—
   - (a) Water too cool (190 to 200 degrees F. right).
   - (b) Water dirty (causes gray cloud below fat).
   - (c) Water hard (the lime in hard water often causes unreliable results; use rain water or condensed steam).
6. Mistakes in reading fat—
   - (a) Reading too hot (fat expanded; 130 to 140 degrees F. right).
   - (b) Reading too cold (fat contracted, not volume enough).
   - (c) Upper surface of fat not leveled (a few drops of amylic alcohol on top of fat makes a flat surface of the concave one. This is used on cream only).
7. Inaccurate graduation of test bottles—
   - (a) Every bottle should have been tested.

When so small a quantity of cream has to represent so large a quantity, it is exceedingly important that every step in the process be performed with the utmost care.

Strength of Sulfuric Acid.—The strength of acid holds a definite relation to its specific gravity, as shown below:

Sp. gr.	Per cent strength
1.841	97
1.840	96
1.839	95
1.837	94
1.834	93
1.830	92
1.825	91
1.820	90
1.815	89
1.808	88

QUESTIONS

1. When, where and by whom was the Babcock test invented?
2. Why do we use a 17.6 c.c. pipette for testing milk?
3. What is the specific gravity of normal milk?
4. What is the specific gravity of normal cream?
5. What is the specific gravity of butter fat?
6. Give the name, specific gravity, and strength of the acid used in testing.
7. How much acid should be used when testing milk?
8. Should a milk sample be mixed at once after adding acid?
9. What should be the temperature of milk for testing?
10. Should the test bottles be kept warm while in the tester?
11. How should a milk test be read?
12. Describe the appearance of a perfect test.
13. Wherein and why does the testing of cream differ from that of milk?
14. How would a cream test be read? Why?
15. How would you test skim milk?
16. How much acid would you use in testing skim milk?
17. How would you test whey?
18. How would you test buttermilk?
19. How would you test cheese?
20. How would you test sour milk?
21. What would you do if the water were very hard?
22. How would you determine whether the acid was of proper strength?
23. Would chemically pure acid give better results?
24. Would it change the reading of a test to run the tester too fast?
25. What style of test bottle is best for testing milk?
26. What color should the tests be just before they are put in machines?
27. What can be done in case they are getting too dark?
28. Would a closed machine do better work than an open one?
29. How may a hand tester be heated on the farm?
30. What is a centrifuge?

CHAPTER XXIX

CREAM SEPARATION

The centrifugal cream separator is to the dairyman what the reaper is to the grain grower, a harvester in fact (Figs. 112 and 116).

Milk fat has a specific gravity of about 0.90 and skim milk about 1.036. Therefore, the fat weighs 87 per cent as much as the skim milk or milk serum in which it is floating. The globules of fat, too, are so small, being only about $\frac{1}{10,000}$ of an inch in diameter, that they rise slowly and with difficulty in milk.

For cream to rise naturally and even reasonably well the milk must be kept cool and left undisturbed for about twenty-four hours. Even then there will be a loss of butter fat of between 0.25 and 0.50 per cent in the skim milk.

If a herd of ten cows yields an average of 5000 pounds of milk yearly, and the skim milk tests 0.40 per cent fat, there will be a loss and virtual waste of about 160 pounds of butter fat. This at 30 cents a pound is worth $48, or nearly enough to pay for a good cream separator.

This machine, now so common on the farms of the northern and eastern states, is finding its way onto the farms of the southern states also, as fast as livestock farming takes the place of cotton growing.

The centrifugal cream separator leaves only from 0.01 to 0.03 per cent of fat in the skim milk, yet it is based on the same principle that operated in the case of gravity creaming, namely: The difference in the weight per volume of the two substances, the milk fat and the milk serum. This is known as specific gravity. The high speed of the bowl throws the milk out against the wall with a force of from 80 pounds in the smaller, slower-running machines to as much as 100 pounds per square inch with even the larger hand separators. The fat is thereby literally squeezed inward while trying to fly outward, because the serum being

heavier is thrown outward with a yet greater force. As the bowl fills from the hopper above it naturally overflows, the skim milk escapes from the openings that lead from the wall, and the fat, mixed with enough milk serum to make it flow, escapes as cream from an opening which leads from near the center of the bowl.

To make a richer cream the normal way is to change the relative positions of the two outlets, moving the cream screw inward or, in some machines, moving the skim milk screws out-

FIG. 112.—There are many makes of hand cream separators having value. This illustrates a few of those used at the Minnesota School of Agriculture.

ward. This makes the bowl carry more milk, increases the force, that is, the squeeze, and results in a richer cream—and vice versa.

"Why do cream tests vary so from the same machine?" This question has been asked and variously answered a great many times but is still a live question. The following are the chief causes of unintentional variation in the fat content of hand separator cream as sent to market:

1. *Speed of the separator.*—The faster the bowl revolves, the richer the cream will be. Slow turning is one cause of thin cream, though some makes of separators are more sensitive to this influence than others. A woman or a child often is not

strong enough to produce a rich cream. Letting down the speed of the handle from 60 to 45 revolutions per minute, cuts the force down nearly a half.

2. *The amount of dirt in the bowl.*—As the slime accumulates in the bowl, the cream becomes thinner but there will be more of it. There may not be an increased fat loss until long after the cream has begun to run thin.

3. *Rate of inflow of milk.*—The faster the milk goes in, the thinner the cream will be. If the milk hopper is kept full all the time, the cream will test less than it will if the machine is allowed to run empty occasionally.

4. *Per cent of fat in the milk.*—A rich milk yields a richer cream than a thin milk, even when the separator is run exactly the same in the two cases. Rich cream for whipping can easily be produced by turning some of the cream just separated back into the milk to come through a second time.

5. *Temperature of the milk when separated.*—Cold cream is thicker and more sticky than warm cream and when flowing out of the bowl drags along the sides of the cream screw and effects a change in relative points of outflow of skim milk and cream, thereby causing a richer cream to be delivered when the milk is cold than when it is warm. To do best work, most machines require a milk temperature of 75 degrees or above.

6. *Cream will rise on cream.*—Cream that has stood a few hours will be much richer at the top than towards the bottom. If the top be poured off to make butter at home, the portion sold will be thinner than the average.

Efficiency in Skimming.—The quantity of fat lost in the skim milk from centrifugal cream separators is largely a controllable matter. The chief factors are as follows:

1. **Speed of the Machine.**—The thoroughness of skimming or completeness of the removal of the fat is a result of force acting through time. If more force is applied a shorter time will be required, or in other words, the milk need not remain in the machine so long to have the same work done upon it. It therefore may be put through more rapidly. If the flow through the machine is held constant, however, the effect is toward a more

thorough skimming. Some of the very close skimming machines get that ability from the very high speed at which the bowl is spun.

2. **Temperature of Milk.**—Warm milk is more fluid than cold milk and less viscid. Therefore, with any given speed of bowl and flow of milk the small fat globules are going to be most fully recovered or captured in the milk which is warm. The same very small fat globules which would rise slowly and with difficulty under the old gravity system will be the most difficult to recover mechanically, therefore require a warm fluid milk.

3. **Nature of the Milk.**—The milk of some breeds of cows contains fat globules of smaller size than that of others. The large globule milk will skim slightly more easily, but not enough to notice in practice.

Stripper cows yield milk which is more viscid or slightly thicker than fresh cows. Such milk should have both a warm temperature and full speed for thorough work.

Dry feed, that is hay and fodder in winter, without silage or roots tends also to increase the difficulty of skimming. Milk yielded on grass separates more easily than winter milk.

Goats' milk is said to be very difficult to separate.

4. **Steadiness of Bowl.**—The cream within the bowl is flung outward with considerable force, therefore lies close against that part of the whole mass which will eventually be delivered as skim milk. This being true, there must be a fine line between the cylindrical sheet of milk and cream which any vibration will tend to destroy. A trembling bowl cannot skim as well as the same would if it ran smoothly.

A solid foundation and a perfectly level setting are essential to best work. In northern sections it is advisable to set one large or four smaller posts into the ground deep enough to go below the frost line to prevent the separator being thrown out of line by the heaving or bulging of the cement floor in winter.

5. **Care of the Machine.**—Many or most cream separators are neglected. Water or milk is allowed to gain access to the gear box and to remain until the cogs have rusted. Poor oil is

too often used and not enough of any sort. Those machines that have the horizontal speeding devices especially need attention in the matter of oiling. Care should always be taken to keep all oil caps working freely. Dust should be kept from blowing into the bearings.

All starting should be done gradually to save strain on cogs, worm and bearings. Since the striking force of any moving body varies directly with its mass but as the square of the speed, it must be expected that those separators that are geared to be run at a high rate of speed will require more attention if not also wear out quicker than those that run at a slower rate.

Cleaning the Bowl.—Unfortunately the weakness of human nature has been added to by the advice of some separator agents who, to make sales, have instructed the purchaser that it was not necessary to wash the bowl every time it was used, that to wash it every two or three days was enough if the thing be well rinsed. Such advice is wrong, as any one will soon find who endeavors to sell sweet cream from an unwashed separator. Merely rinsing or spinning the discs in water is not enough to keep them in good condition. A few mechanical washing devices work very well for a hasty wash, but the particles of matter cling so tightly to the discs, wings and other inner parts that a sound scrubbing with a brush or coarse cloth is necessary.

Directions for Modifying Milk and Cream.[1]—The simplest and most accurate method of modifying or standardizing cream or milk to any desired standard of butter fat is that developed by Pearson. This method, discussed below, is applicable not only in market milk and cream work but in ice cream making also.

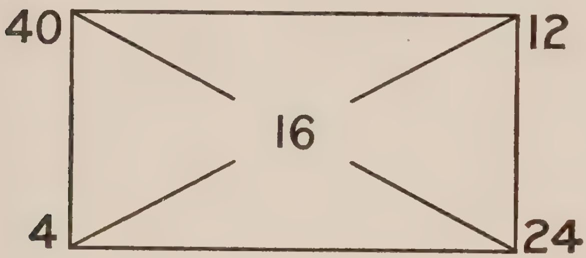
Example 1.—Given a 40 per cent cream and a 4 per cent milk, to be mixed to produce a 16 per cent cream. The amount to be used can be determined very readily by the following procedure:

[1] This section on the modifying of milk and cream is taken largely from the author's bulletin, Principles and Practice of Ice Cream Making. Vt. Sta. 155.

(1.) Subtracting the figure representing the desired quality from the known cream fat percentage to obtain the amount of milk to be used.

(2.) Subtracting the known percentage of the milk from the desired percentage of the mixture to obtain the amount of cream to be used.

Thus, in the above stated example, 40 — 16 = 24, 16 — 4 = 12. This can best be illustrated by drawing a square and placing the figures as shown in the accompanying diagram:

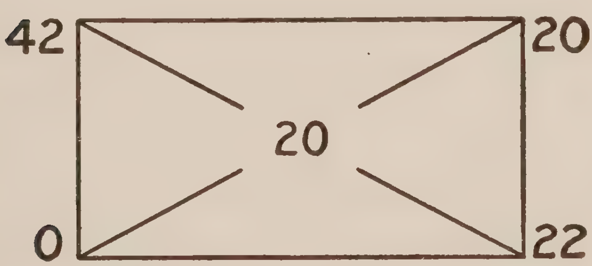


(16 — 4 = 12)

(40 — 16 = 24)

It will be noticed that in this particular example the proportions of cream to milk are 12 : 24; that, in other words, by mixing together 12 gallons of 40 per cent cream and 24 gallons of 4 per cent milk there will be obtained 36 gallons of 16 per cent cream.

Example 2.—Given a 42 per cent cream to be reduced by skim milk to a 20 per cent cream. The square will be:



(20 — 0 = 20)

(42 — 20 = 22)

Mixing in the proportion of 20 cream and 22 skim milk, the result is attained. Figuring as before for proof:

$42 \times .20 = 8.40.$

$.00 \times .22 = 00.$

$8.40 + 00 = 8.40.$

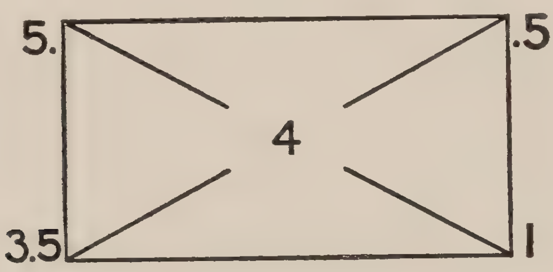
$20 + 22 = 42. \quad 8.40 \div 42 = .20.$

If one wishes to know, for example, how much cream should be added to 10 gallons of skim milk to make a 20 per cent cream, one figures as before. 22 : 20 :: 10 : x. This gives 9.09 gallons. as may be proven thus:

$$
\begin{array}{rcl}
.42 \times 9.09 = & 3.82 & \\
00 \times 10 = & 0.00 & \\
\hline
19.09 \;) & 3.820 \;(& .20 \text{ per cent of fat} \\
 & 3.818 & \\
\hline
 & 20 &
\end{array}
$$

Or, reversing the proposition, if one has a 10-gallon can of 42 per cent cream and wishes to know how much skim milk to add to it to reduce it to a 20 per cent grade, one figures 20 : 22 :: 10 : x. x = 11 gallons, which will be found sufficient.

Example 3.—Given milks carrying 3½ and 5 per cent fat to be mixed to make 4 per cent milk:



(5 — 4 = 1)

(4 — 3½ = ½)

½ : 1 :: 1 : 2. Hence one can of the lower and two of the higher grade will make three cans of the 4 per cent grade.

Any other figures may be used as desired; as, for example, 4.6 and 3.3 to make a 3.7 per cent grade. 4.6 — 3.7 = 0.9 3.7 — 3.3 = 0.4. Four parts of the higher grade and nine parts of the lower are called for.

Another very convenient tool in this connection is a rule by means of which one may find directly how many gallons (or pounds) of rich cream and skim milk will be required to produce any definite number of gallons (or pounds) of cream testing any definite percentage of fat. The rule is: Multiply the amount of cream desired by the test of the cream desired and divide this product by the test of the rich cream at hand. This

will give the amount of the rich cream required for the mixture. The difference between the amount of cream desired and the amount of rich cream required will indicate the amount of skim milk required to be mixed with the rich cream to produce the desired result.

Weight of Cream Per Gallon.—Since butter fat is only about 87 per cent as heavy as skim milk and since the lighter substance varies greatly in amount in cream, it must be expected that the weight of a given volume of cream will vary with its fat content. When cream is sold by weight, and paid for by the gallon, it is quite important to know the number of pounds in a gallon of cream of varying grades. Below are shown the specific gravity and weight per gallon of water, milk and cream of various fat contents:

	Specific Gravity	Weight in lbs. per Gallon
Water	1.000	8.34
Skim milk	1.037	8.64
4% milk	1.032	8.60
10% milk	1.025	8.54
15% cream	1.018	8.48
20% cream	1.013	8.44
22% cream	1.011	8.42
24% cream	1.009	8.40
26% cream	1.008	8.40
28% cream	1.006	8.38
30% cream	1.004	8.36
35% cream	.999	8.32
40% cream	.995	8.29

QUESTIONS

1. How does a separator separate?
2. How much fat is lost in skim milk with gravity creaming? With mechanical creaming?
3. What is the normal way of changing the fat content of cream?
4. Explain reasons for fat variation in separator cream?
5. How must a separator be set if it is to do good work?
6. Explain on the board how to modify milk or cream to any given fat percentage?
7. What is the weight of a gallon of water, skim milk, milk, and 35 per cent cream?

CHAPTER XXX

CARE AND RIPENING OF CREAM ON THE FARM

The price of butter depends more largely upon its flavor than upon all other qualities put together. The flavor of butter is due almost wholly to the kind and amount of bacterial growth which takes place in the cream before the butter is made, often before the cream ever reaches the place of manufacture.

On March 1st, 1916, the prices of creamery butter on the New York market were as follows: Special high score, 37 to 37½ cents; extras, 92 per cent score, 36 to 36½ cents; firsts, 90 to 92 per cent score, 35 to 36 cents; seconds, 87 to 90 per cent score, 33½ cents; ladles, 23 cents. The difference in price between the 33½-cent and the 37½-cent butter was due entirely to flavor or tasty quality. The price is seldom influenced materially by the amount of salt or moisture or fat in the butter and usually not materially influenced by workmanship. The difference, 4 cents, is nearly 12 per cent of the price quoted for seconds or, in other words, a more pleasing flavor would have enabled the manufacturers of that butter to have sold it for 12 per cent more than was obtained. When butter is more plentiful, as in spring and early summer, the difference in price is even greater. In the case of the 23-cent butter, there are defects other than mere flavor to cause the discouragingly low price, though the fat in it cost the farmer the same to produce as that which sold for almost twice as much.

The value of cleanliness is nowhere more manifest than in the dairy. The price depends on flavor, flavor depends on bacteria, and bacteria depend on the dirtiness of the cow's teats, the milker's hands, pail, strainer cloths, and separator. If all these be clean the cream is well started on the road toward a choice butter and high price.

A cool temperature following quickly after separating is exceedingly important to a cream and butter of good keeping quality. The rate of growth of bacteria at the temperature of 50

degrees compared with 70 degrees is well shown in figure 115. It is seen that as a rule the degeneration of cream is many times more rapid at the temperature of 70 than at 50 degrees. Only about twenty minutes under good conditions is required for one germ to mature and split into two germs. To prevent rapid growth the cream should be cooled immediately after separating to a temperature of 50 degrees or below. Clean cream cooled at once in ice water will keep sweet a week or ten days very readily. Milk has been kept four weeks and cream five weeks without the aid of anything except coldness. Under plain farm conditions the cream may, by the use of cold well water, be kept three to four days if it were produced in a cleanly manner.

In practically all the northern states the deep well water has a temperature of 45 to 52 degrees and serves very well in cooling cream if arrangements be provided as in figures 113 and 114, in which all the water pumped by windmill or gas engine for the stock flows first around the cream cans and thence to the cattle and horses. Where an arrangement of this sort is not practicable, ice should by all means be provided. Where the cream only is cooled, one ton of ice will suffice for two cows for the season in the northern states. If the ice costs $2 per ton or $1 per cow a season, the profit on the investment will amount to at least $4 per cow after paying for the ice, and often to twice this amount, through the increased value of the cream.

Frequency of delivery has much to do with quality. While it is a fact that cream may be produced so clean and kept so cold as to remain sweet two weeks or more, it is also true that under most American conditions, even in the recognized dairy sections, plans should be made for the delivery of the cream to the creamery or its making up into butter at least three times a week in summer and twice in winter.

Cream grading and payment for and on quality has long been advocated. It has been recognized for years that clean sound cream is worth more than that which has undergone partial breaking down of one or more of its constituents. But for various reasons, chiefly business rivalry, grading has not yet become general. It is being done, however, in various localities,

a difference of three to four cents being made between the first and the second class cream, and two to three cents between second and third classes. It is both illogical and unfair to pay as much for the fat in poor cream as for that in good.

Fig. 113.—Milk cooling tank, cover off to show arrangement of cans. All water pumped for the stock passes first through this tank. (Courtesy Minnesota Tank and Silo Co., Minneapolis, Minn.)

Cream Ripening.—What is it? By cream ripening is meant the process of allowing or forcing the cream to become sour by means of a certain kind of bacteria which, while generating acid, also produces a thick glossy condition and an agreeable flavor.

Why is it done? For the purpose of improving the flavor, increasing the yield of butter through a reduced loss of fat in the buttermilk and to shorten the time required to do the churning. The latter two benefits are brought about by the fact that the acid coagulates the casein and renders it brittle.

FIG. 114.—Milk cooling tank, cover in place. (Courtesy of Minnesota Tank and Silo Co., Minneapolis, Minn.)

How is it done? There are two more or less distinct methods: (1) the farm dairy method; (2) the creamery method.

1. In what may be called the farm dairy method the process is direct and simple. The cream is held after separating for one

to three days in cans in cold water, and then about twelve to eighteen hours before the butter is to be made, all the cream to be churned is poured, if possible, into one vat or can, thoroughly mixed, warmed to about 70 degrees in summer or 75 degrees in winter, and left to sour. It should be stirred frequently to prevent curd clots from forming in the bottom of the can or vat. When the cream has become somewhat thick and glossy and pours like thick milk gravy it is about ripe enough and should be cooled to about 53 degrees to prevent further rapid growth of the lactic acid bacteria, also to temper the fat that firm butter may be made. After the cream has stood cool for four or more hours it will be ready for churning (Fig. 115).

If the cream is held for a longer period than about three days there is danger of a bitter flavor and an old cream taste developing. The bitter germ is favored by a temperature between 40 and 50 degrees, but grows slowly. On the other hand, if the cream be warmed to a temperature of 85 or 90 degrees it is liable to develop a gassy, foul-flavored condition. The germ that produces gas in milk and cream is usually one of the colon group, which lives naturally in the alimentary canal of cows and other warm-blooded animals. The warmer temperature in cream therefore naturally favors the growth of such bacteria.

Can cream be ripened too much? Indeed, it can. If the souring temperature, about 70 degrees, be maintained for too long a time the acid will literally kill off the very kind of bacteria that produced it and the cream will take on an old and a harsh taste. Butter made from such over-ripe cream will not keep as well as that made from cream containing less acid.

Cream is in best condition to churn well and still produce a good keeping butter when it contains about 0.45 to 0.50 per cent acid, if the cream test 35 per cent fat; or 0.55 to 0.60 per cent acid if the cream contains only about 25 per cent fat.

When the cream has stood warm until sufficiently sour as shown by one of the chemical tests, and the senses, it should then be cooled to a temperature of about 52 or 53 degrees or even lower in summer, or 56 degrees in winter, and held at that tem-

perature for at least four hours in order that the butter fat may have time to solidify, or temper.

When once thoroughly soured and cooled, cream may be held for a day or two if necessary without great injury. The presence of the lactic acid prevents most other forms of bacteria from growing, whereas if it were endeavored to keep the cream sweet by low temperature for four or five days it is probable that a bitter, unpleasant-flavored bacterial growth would have occurred.

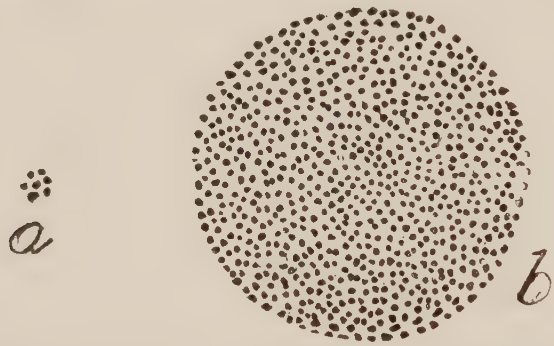


FIG. 115.—Showing the effect of temperature on rate of growth of bacteria. *a* at 50° F., *b* at 70° F.

2. The creamery system consists first in pasteurizing the cream for the purpose of destroying all, or as many as possible, of the bacteria that were brought in by the patrons and then souring or ripening it by means of a starter prepared from a pure culture grown for the purpose. A starter is essentially only a quantity of clean-flavored sour milk used to hasten and to control the growth of bacteria in the cream. This process is too long and complicated for farm dairy use.

QUESTIONS

1. What relation is there between care of cream on the farm and price received for the finished butter? Explain.
2. How does cold temperature of cream preserve its quality?
3. How long after separating is it safe to try to keep cream before it is made into butter?
4. What difference in price is it fair to make between sweet, clean cream and that which is sour and off flavor?
5. What is meant by cream ripening?
6. Why is cream ripened?
7. How is cream ripened?
8. May cream be ripened too much?
9. What is meant by tempering cream?
10. Briefly, what is the creamery system of cream ripening?

CHAPTER XXXI

DAIRY BUTTER MAKING

THE large place so long held by home-made butter is now largely filled by that made in a factory, called creamery butter, and the change has come about almost wholly during the past twenty-five years. Whereas formerly every rural home was supposed to make butter sufficient for its needs, if not for sale as well, it is now not at all infrequent to find that on farms where ten to twenty cows are kept no butter whatever is regularly made, creamery butter being purchased for consumption on the farm. This has been in most cases beneficial in relieving the housewife in many instances of a portion of her burden, as well as rendering it possible to secure a greater cash return from the herd through the production of a larger quantity of more uniformly high class butter, and through it the finding of better market.

It is not an unmixed good, however, since some buy who should make. Once the art of making cheese, soap, syrup and the curing of meats was well known and practiced by the people in general. Now these are manufactured elsewhere and the producer must buy when he should have preserved his own. It is to be hoped that butter making does not go the same road.

The Place for Farm-made Butter.—There are places in the northern creamery sections of the country as well as occasional instances in creamery territory where the production of a high class dairy butter for market is being found highly profitable.

The principle underlying the process of butter making is identical whether the work be done on the farm or in the factory, on a small scale or a large. The methods and machines employed to accomplish the work differ in size but not in principle.

Collecting the Cream.—On farms it will be found almost universally desirable to collect the cream as produced from day to day and hold it in well tinned cans. The ordinary four-gallon "shot gun" can, eight inches in diameter and twenty inches high, is excellent. If the cans are rusty or have exposed

iron patches the butter is very liable indeed to have a strong metallic or even a fishy flavor. The cream should be cooled promptly after separation to a temperature between 50 and 45 degrees F. If warm cream is mixed with old cream the whole mass will start souring promptly. Therefore, fresh lots should be kept separate until cold, when they may be mixed with that previously procured. If the cream reaches a temperature of 55 degrees the souring process proceeds quite rapidly. There is no particular advantage in cooling at any time below 40 degrees, however, and 45 degrees will do very well indeed.

For the production of best butter, cream should be churned at least twice a week in winter and three times in summer. In hot climates daily churnings are to be preferred.

Churning.—The churning process consists essentially in a series of concussions which serve to break the curd and to cause the minute globules of butter fat to come into contact with one another and cause them to stick together, growing in size with the addition of others until granules are formed sufficiently large to be easily removed. The process is essentially the same whether done by stirring cream in a bowl, pounding a skin bag filled with milk, plunging a vertical dasher or revolving a barrel churn permitting the cream to fall.

The churn used will vary in size and kind with the amount of work to be done, but some form of barrel is preferable to any in which paddles only revolve or in which the cream slops from one end of the churn to the other, the receptacle not revolving.

All of the so-called "lightning" churns, and most of those made of metal should be looked upon as thoroughly impracticable. Small churns made of earthenware may be perfectly cleansed, and in this respect are desirable. Wooden churns, however, are still recognized as standard. While more difficult to clean and keep sweet, such may be accomplished with care. Wood has the further advantage of being a good non-conductor of heat and therefore aids in holding the temperature of the cream near the desired point, even though the temperature of the atmosphere of the room is higher or lower than the cream within. Another valuable feature of wood is that when well scalded and soaked, butter fat will not stick to it. Butter of

better grain and texture can be made in wooden churns than in metal churns because it is impossible to so prepare metal that the fat will not adhere considerably even under ideal temperature conditions, and badly if the churning is being done at a temperature which is but slightly too high.

To prepare the wooden churn for use, liberal quantities of scalding hot water should be used, primarily, for the purpose of soaking the wood, or in other words, driving the air out of it. When the tissue of the wood has become filled with hot water the whole should be well cooled with cold water in order that the warmth contained in the walls of the churn shall not raise the temperature of the cream. The same principles pertain to the preparation of all woodenware, such as ladles and worker.

Straining the cream into the churn is a wise precaution for removal of particles of curd as well as for removal of sawdust or any other foreign matter which may have fallen into the cream.

No barrel churn should be filled more than one-third full if quick and exhaustive churning is to be done. There must be room left for the cream to fall.

Coloring the butter is accomplished by adding the liquid color to the cream immediately before starting to churn. The quantity used will vary with the breed of cattle, the feed that they are consuming, and the market to which the butter is to be shipped. With Guernsey and Jersey cows on pasture no color will be needed, since their product is naturally yellow. The shade of natural butter varies all the way from a bright orange, produced by Guernseys on blue grass pasture, to an almost pure white, produced by Holsteins, Ayrshires and Shorthorns on winter feed. In winter, generally speaking, one cubic centimeter of color for every pound of butter fat in the cream, or one teaspoonful for every gallon of cream will be found abundant. Some colors are stronger than others and care must be exercised to not use too much. The market requirements should also be studied.

The color used is the outer portion of the seed of the annatto plant which grows in the South Sea Islands and South America. The color is incorporated mechanically in cottonseed oil as a carrier. When used, the added color accompanies the oil and is made to surround the many globules of fat. Butter color

is used for the purpose of maintaining a reasonable degree of uniformity in color throughout the entire year or, in other words, to make butter look like butter, the year round, not like butter in summer and lard in winter.

Gas (carbon dioxide) develops in cream with the growth of the bacteria, which is released with a few revolutions of the churn. In all tightly closed barrel churns the gas should be given opportunity to escape once, and usually twice.

The speed of churn should be as rapid as possible and still secure the maximum of concussion or pounding of the cream within. This naturally will vary with the thinness of the cream and the amount in the churn.

At this point in the process the churning should be continued evenly until the globules of fat have assembled into granules and the granules grown to be sufficiently large for easy and thorough removal.

When to Stop Churning.—If the churning process is continued too long the butter will gather into larger and yet larger lumps until finally the entire mass is in one or two great chunks or balls. Such butter is over-churned and has incorporated throughout its entire mass a large quantity of buttermilk. The butter maker at this point is faced with the option of either permitting the buttermilk to remain in the butter mass and there sour and produce a poor butter, or of squeezing and working the buttermilk out, which process is very liable to produce a greasy butter with poor grain and weak body. To obviate both these difficulties the churning process should be stopped when the granules of butter have reached the size of a kernel of wheat or cracked corn. If the cream has been ripened sufficiently to render the casein brittle and if the temperature of the cream and the fat within it has been such that the particles of fat can stick together when they do touch, the process of churning need not have consumed more than twenty minutes. To churn with a hand churn more than twenty to twenty-five minutes is a waste of labor. Where a larger churn driven by power is used it is preferable to cool the cream to such a temperature that the butter will not come in less than about thirty minutes nor more than forty-five.

Drawing off the buttermilk is best done by allowing the churn to stand quietly a few minutes until the granules of butter have risen to the top, when the buttermilk below may be drawn off through a sieve quickly and with slight loss of butter. The temperature of the butter at this time should be taken.

Washing the butter is done for the purpose of removing practically all of the buttermilk remaining in the mass. The water, naturally, should be clean and of a temperature ranging from the same to two degrees lower than the butter at the time the buttermilk was drawn. In farm practice the butter should be washed twice, using each time fully as much water as there was cream at the start. The churn should be revolved two or three times with each wash water to insure a more thorough removal of the buttermilk. The last wash water should be kept on the butter until the salt is ready to be applied when the temperature of the work room is too warm, 65 degrees or above.

Salt is used in butter for two purposes: To give flavor and to preserve the butter. A few people, however, prefer the flavor of unsalted, or so-called "sweet butter." They should expect, however, that such will become rancid or moldy in a very much shorter time than would be the case had salt been mixed with the same butter. The presence of salt to the amount of $2\frac{1}{2}$ per cent of the total butter is protection also against molding. Neither green mold nor the ordinary black mold can grow in the presence of such a quantity of salt. To make butter contain $2\frac{1}{2}$ per cent of salt in the finished article it is necessary to add it in amount from 7 to 10 per cent, varying with the fineness of the salt, the amount of water left in the granules of butter in the churn, and the amount of butter made in proportion to the size of the churn. A small batch requires more in proportion. The more water remaining in the butter the greater will be the amount of salt washed away. Fine salt, likewise, dissolves more quickly and wastes more readily than coarse salt. Coarse salt has the disadvantage, however, of being slow in dissolving, requiring from fifteen minutes to an hour to go into solution. So long a time as this, however, will often cause the butter in the churn to become warm and altogether too soft for good working, or in winter to become too hard. It is desirable

to work sooner, but if the working process be continued while the coarse grains of salt are undissolved they will grind and pierce the granules and globules of butter fat to such an extent as to make the whole mass salvy and oily in texture and flavor. It is highly desirable that salt for butter making be fine in texture.

Salt as ordinarily offered on the market varies considerably in its purity. Some which is designed for use in butter is in reality unfit because containing chemical impurities such as plaster of Paris, which renders the salt difficult and slow of solution. These impurities are liable indeed to cause the salt to remain hard and granular, like so much sand. So far as known they have no injurious effect upon cattle, but certainly render butter less valuable. Aside from these chemical impurities some salt has been exposed to dust, so when a teaspoonful is dissolved in a cup of water it leaves a gray film of dust on the surface. Such salt should not be used. Again, salt will absorb odors if it has been stored where such is possible. The unpleasant odor of a close warehouse, general store, or kitchen is not infrequently discernible in salt and in butter when such salt is used.

To distribute the salt evenly throughout the butter with the least possible amount of pressing or digging of the butter, the salt should be added in the churn. This is best done by drawing the second butter wash water thoroughly. The churn should then be rocked backwards sufficiently to throw the granular mass of butter against the wall of the churn opposite the drain hole. With a small ladle a thin layer of butter is then sprinkled upon the floor of the churn. Upon this salt is sprinkled. A second layer of butter is then drawn lightly upon the first. Thus, layer upon layer, the salt and butter are mixed. If the temperature of the room will permit, the butter should, at this point, be allowed to stand for at least five minutes to permit the salt to dissolve and the excess water to drain away, at the end of which time the butter should be pressed together firmly enough to permit it to be worked. If a separate worker is used it should be thoroughly scalded and cooled. After a slight amount of working to more thoroughly press together the many granules of butter the mass should again be permitted to stand several minutes to give the salt time to completely dissolve.

Working is done for the purpose (1) of distributing the salt thoroughly and evenly throughout the whole mass of butter, (2) of pressing out the superfluous water and (3) of forming the granules of butter into a solid mass. The worker which will do this with the least amount of grinding or smearing and which is also inexpensive and easily cleaned is the best worker. That known as the lever butter worker, made in various sizes, is unquestionably the most satisfactory all-around instrument where a small quantity of butter is to be made.

Here the butter should be spread evenly and worked by means of the five-sided lever. The working consists in a folding and pressing process. The loose crumbs of butter must be gathered in from time to time and the near and far, not right and left, edges of the flat layer of butter turned inward. This folding in and pressing out process is to be continued until the salt is dissolved and evenly distributed and the butter has assumed a compact mellow, waxy consistency, when working should cease. Too much working causes oily texture and flavor.

Where butter is to be made from a herd of twenty or more cows one of the small-sized combined churn-and-worker (Figs. 116 and 117) is to be recommended. They are now made in sizes sufficiently small to churn and work 25 to 50 pounds of butter very satisfactorily. The principle involved in the roller within must conform with those indicated as necessary for the outside worker, namely, that the butter shall be folded and pressed rather than ground and sliced. Care should be taken in selecting a combined churn, as some are superior to others.

Packing.—Earthen jars are still recognized as the most satisfactory receptacle for butter so far as the keeping qualities of the butter are concerned. Butter made from mildly ripened cream in September and October, carefully washed, moderately salted and solidly packed in clean earthen jars, covered with a quarter inch of salt paste, and placed in an ordinary farm cellar will keep so well as to be very usable throughout the entire winter. It would be desirable, however, under such circumstances to freeze the jars of butter at the beginning of the winter and to thaw out one at a time when needed for use. Jars have the disadvantage, however, of being somewhat expensive unless

FIG. 116.—Cream separator churn and butter worker suited to the needs of the small dairy.

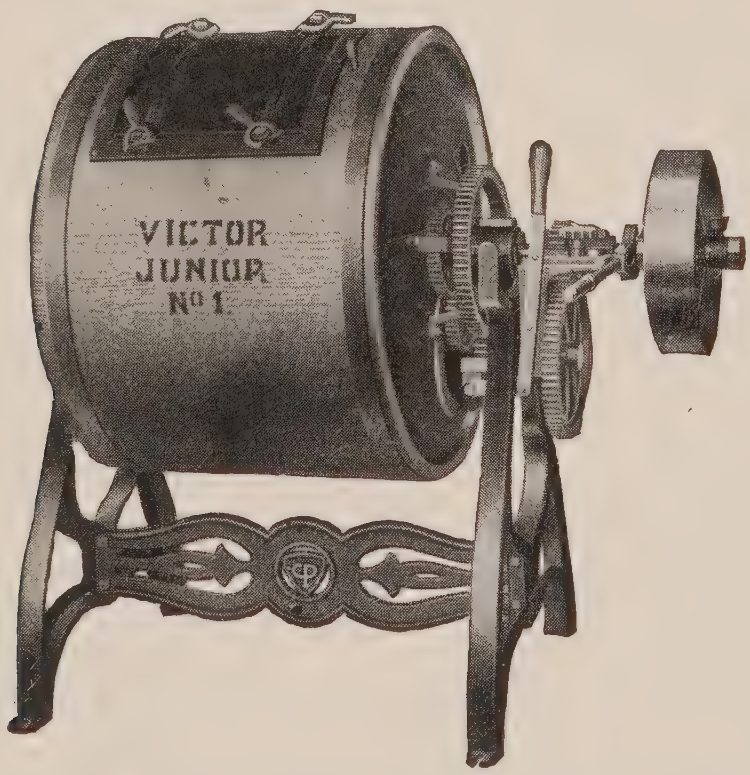
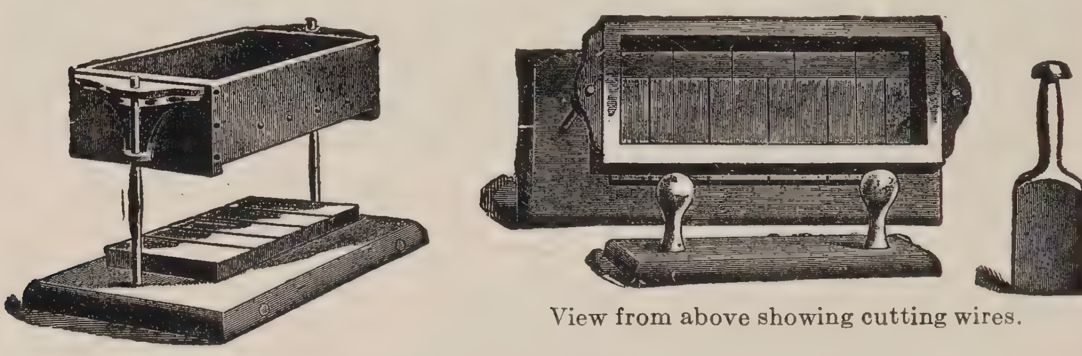


FIG. 117.—A cylindrical churn and butter worker combined.

they can be returned, and of being heavy and easily broken. Butter cut from jars also is irregular and often ragged in appearance. For these various reasons the pound print has come into favor in all sections of the country.

Print tools which will form from one to a dozen pound cakes at one time are on the market (Fig. 118). The single print, however, is not desirable for regular use because it is slow and because the butter packed into it is too liable to become smeared and greasy from much handling. It is convenient to have one ready, however, in order that small special orders may be more neatly filled. The print shown in figure 118, which will make eight to twelve pound-prints at one filling, is thoroughly practical where small amounts are made. The form



View from above showing cutting wires.

FIG. 118.—A multiple butter printer which cuts the prints apart with wire.

known as the Friday is very convenient, especially where the butter is liable to be soft when made and requires hardening in the refrigerator before being cut into pound bricks and wrapped.

The paper used for wrapping butter should not be coated with paraffin, but should be parchment paper. The carton should, however, be thoroughly well paraffined inside to prevent evaporation of moisture, and absorption of odors by the butter.

General Caution.—The fat which is later to be made into butter exists in the milk and cream in the form of very minute round balls, varying in size, but averaging about $1/10,000$ of an inch in diameter. The reason for churning is to stick these little globules together into larger masses called granules. The reason for working is to form these granules into a single mass. The object especially to be held in mind throughout the entire process is to collect and assemble these small particles without in

any way bruising or disrupting the small particle itself. If one globule is broken or pierced and made to flow into another, the butter becomes to that extent salvy and greasy. To overwork the butter is to give it somewhat the condition which it would have if it had been melted. It is not incorrect in this connection to think of the butter fat globule as a single grape. Many, when gathered in clusters, form a unit bunch of grapes, yet each individual on the bunch should be perfect. The bunch, or, in this simile, the granule of butter, may then be assembled into larger masses, the grapes into baskets, the butter into jars. Yet, just as it is desirable that every bunch of grapes and every grape on each bunch be perfect, so is it desirable that the fine units, the granules and the globules of butter fat remain perfect.

Marketing.—The old way of bringing the farm butter to the country grocery and there trading it for goods is about the most unprofitable, uninspiring method of marketing known. Where a passably good dairy butter is made regularly, customers can usually be found who will pay well for it. The butter maker is also stimulated to do a little better work when the consumers of the butter are known. There is a wider field open, however, to those prepared to produce a high class dairy butter, who also have had training in selling. Many wealthy people in cities gladly pay from 40 to 60 cents a pound for choice dairy butter. The chief difficulty of utilizing this market is that of transportation. To express a small quantity in an ice box is expensive, while to send by parcels post is unsatisfactory, because the butter will melt in transit and deteriorate in quality very rapidly, so that when received and cooled it will not be the choice butter that it was when started.

The selling of butter to neighboring farmers is coming to be quite an industry in regions where whole milk is shipped to cities, and also to some extent in communities where cream is regularly sent to the creamery and where the housewife prefers to buy from a neighbor rather than to go to the labor of churning the small quantity needed for the home table. The writer has met a few enterprising farmers doing a flourishing business in providing butter, cured meats, and eggs to neighboring farmers.

The causes of difficult churning in winter are practically only two in number. First, the cream from which the butter is attempted to be made has too often been kept so cold that the bacteria producing the lactic acid, which in turn makes the casein of the cream brittle, have not been able to grow. Thus the cream remains sweet and tough, almost leathery in consistency. To overcome this difficulty the cream must be warmed and given time to sour. The second cause is a low temperature. Butter fat at a temperature of 100 degrees F. is a liquid, while the same globules at a temperature of 40 and even at 50 degrees are so hard that they cannot stick together when they do touch in the churning process any more than two tallow or wax candles will adhere when knocked together. There is no necessity for consuming more than half an hour in the churning process. To obtain results, however, it is essential that the cream be sour and that the temperature be high enough to cause the butter fat to be slightly sticky. The churning temperature will vary all the way from 55 degrees in summer up to 65 degrees in winter. The higher temperatures will be needed where the cows are fed considerable quantities of cottonseed meal, lower temperatures where more corn is fed. As a general rule 56 to 60 degrees will be found desirable in the west and 58 to 64 degrees in New England and the southern states. With cream adequately ripened the length of time required to churn will regulate the temperature at which to churn. While it is true that stale cows and dry feed aggravate the case they become of little importance to one who will remember to "sour the cream and churn at 60."

Butter Overrun.—The question is often asked why or how it is that the creamery managers can pay to the farmer as many cents per pound for the fat as are received for the finished butter. The question also frequently calls into question the accuracy or honesty of the testing. Then when the farmer is able to churn a quantity of cream and from it secure considerably more butter than he could be given credit for in pounds of fat at the creamery, he is convinced that fraud has been perpetrated upon him. To both these questions the answer may be given that the result

is due to the overrun, and that by overrun is meant the increase in quantity of butter over butter fat secured by churning. The butter fat paid for at the creamery is the clear oil. Butter is not all oil, but contains water, salt and curd also. The analysis of 100 pounds of ordinary butter shows a composition about as follows:

	Per Cent
Water	14
Salt	2½
Curd	1
	17½
Fat	82½
	100

In other words, 82.5 pounds of fat, by the addition of water, salt, and curd, has been made to become 100 pounds of butter.

Viewing the same matter slightly differently we may figure that 100 pounds of fat taking up 19 pounds of water, 3.5 pounds of salt, and 1 pound of curd, will produce 123.5 pounds of butter.

In good home dairy practice the test of the cream may be ascertained with a fair degree of accuracy by churning it, weighing the butter, and subtracting from the weight of the butter, one-sixth its weight, and then dividing the remaining five-sixths weight by the number of pounds of cream used at the start. This method of checking should show an agreement within 2 per cent of fat with that allowed at the creamery.

Under skillful method of manufacture the quantity of butter over fat may be as high as 22 per cent without the incorporation of such a quantity of water or salt as to render the butter either inferior or illegal. And if the overrun falls as low as about 16 per cent regularly, something is wrong. The cream may be inaccurately sampled or tested, the fat loss in the buttermilk may be excessive or some other leak is present. Buttermilk should not test more than 0.05 or 0.09 per cent fat.

The composition of butter varies somewhat with the methods and temperatures used in making. Butter may easily

vary in composition, as will be seen by the following table of composition of two samples, A and B:

	A Per Cent	B Per Cent
Water	12	15
Salt	2	3
Curd	1	1
Fat	85	81
Totals	100	100

It will be noted from the above two examples that whereas in "A" 85 pounds of fat were required to produce 100 pounds of butter, only 81 pounds were required to produce 100 pounds in the case of "B," a difference of 4 pounds, which at 25 cents per pound would make a difference of one dollar per 100 pounds, or one cent a pound. Differences even greater than those indicated occur in practice. The amount of butter which a given quantity of cream will produce will easily be one-sixth greater than the amount of fat in that cream, as shown by the Babcock test, and many calculate butter yield on the basis of one-fifth increase. It is not desirable that the butter-maker endeavor to incorporate any unusual amount of water. There is danger that an illegal amount be retained as well as danger of an inferior article being produced. It is desirable, however, that from 2½ to 3 per cent salt be incorporated. This is to assist in preserving the butter, while it is being held at moderate temperatures. In cold storage where all is frozen hard the unsalted butter keeps as well as the salted (Fig. 119).

Market Classes of Butter.—Butter now made in America possesses all shades of quality from the choice creamery, scoring 96 to 97 per cent and commanding several cents premium in price, to packing stock or renovating stock which cannot well be scored and is a drug on the market at less than half the price paid for the best.

The butter which makes the market, however, scores usually between 85 and 95 per cent. The grade is established by a score based on the several qualities that the butter should possess. In the following table are shown the points considered, the weight

or count given to each and essentially or approximately how butter of the four recognized grades would score. The flavor is most important, yet the body may be " weak " or " crumbly"; the color a little " wavy "; the salt too light or " undissolved," or the package " untidy " or damaged.

Score Cards		Market Classes and Scores			
Points	Full Score	Choice	Extra	Firsts	Seconds
Flavor	45	41	39	37	35.5
Body	25	25	25	24	23.5
Color	15	15	14.5	14.5	14
Salt	10	10	9.5	9.5	9.5
Package	5	5	5	5	4.5
Total Score	100	96	93	90	87
Price (Illustrative)		35c	34c	31c	28c

Forms of Selling.—In what form it is preferable to sell the product of the dairy will naturally be settled in many or most places by local circumstances. Yet some producers are so located that the product may be sold as market milk, as sweet cream, or as butter fat contained in cream. If butter fat is worth 30 cents per pound, how will the sale of sweet 20 per cent cream at 60 cents per gallon compare with it? If we assume a dairy of twenty cows yielding 25 pounds per day per cow or 500 pounds of 3.6 per cent milk we shall have 18 pounds ($500 \times .036 = 18$) fat, which at 30 cents per pound is worth \$5.40. If this be sold in the form of 30 per cent cream there will be 60 pounds of such cream and 440 pounds of skim milk, which, at 40 cents per hundred, has a value of \$1.76, making a total of \$7.16.

The 500 pounds of 3.6 per cent milk will produce 90 pounds of 20 per cent cream.

Pounds Milk : pounds cream :: per cent cream : per cent milk

$$500 : x :: 20 : 3.6$$

Since 20 per cent cream weighs 8.44 pounds per gallon there will be 10.66 gallons of cream, which at 60 cents per gallon will be worth \$6.40. The skim milk remaining (500 pounds milk minus 90 pounds cream equals 410 pounds skim milk) is worth about 40 cents per hundred or \$1.64. This brings the total

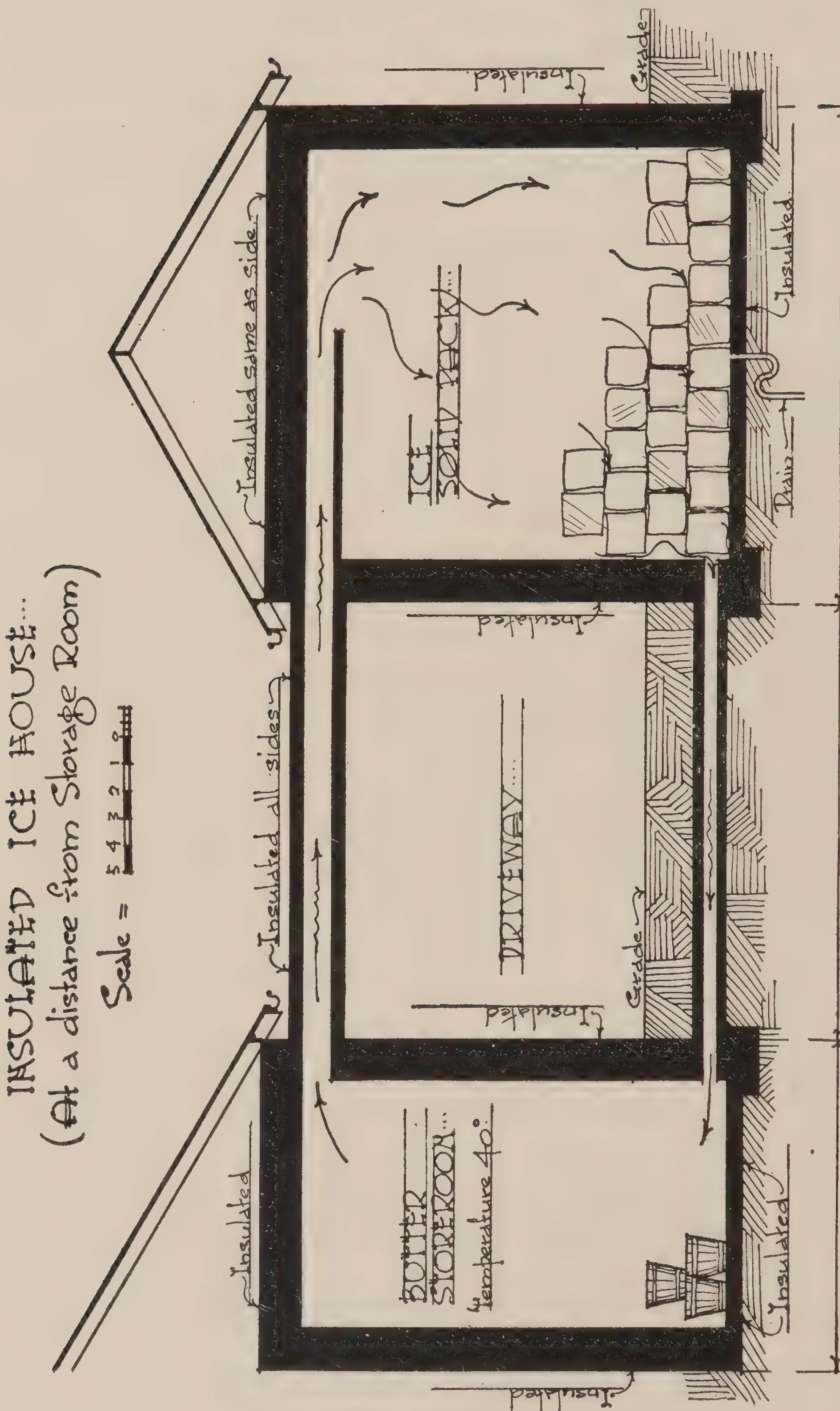


FIG. 119.—Illustrating method of connecting an insulated ice house to a refrigerator room, even though they are a rod or two apart. The circulation will be continuous and the butter room cold and dry.

receipts up to $8.04. This shows a profit in sweet cream selling over selling fat for butter-making purposes of 88 cents per day on a herd of 20 cows. In practice a slightly smaller sum would be received because of the mechanical losses of fat in handling.

If the same milk were sold at $1.50 per hundred it would bring $7.50, or 54 cents less than in the selling of sweet cream and 34 cents more than in selling butter fat.

If butter be made on the farm from the same milk there

FIG. 120.—Coöperative creameries make dairying profitable.

will be made about 21 pounds. If this is sold at 30 cents per pound the sum of $6.30 will be realized. To this amount should be added the value of the skim milk and the buttermilk remaining, which will be about 480 pounds. This will be worth about $1.92, or a total of $8.22.

Summarizing results we see that 500 pounds of 3.6 per cent milk sold in the four different ways bring the following results:

Milk will bring in	$7.50
Sweet cream will bring in..............	8.04
Butter fat will bring in	7.16
Butter will bring in	8.22

In addition to the figures given there must always be taken into account the equipment and labor cost of caring for and delivering to market the commodities. Where coöperative creameries are organized a satisfactory method of marketing is established (Fig. 120).

QUESTIONS

1. Where should farm butter making be practiced?
2. How should cream be held while collecting enough to churn? How cold?
3. What is churning?
4. Tell how to get a wooden churn ready for use.
5. When and how is butter colored?
6. How long should it take to churn?
7. When should the churning be stopped?
8. Why and how is salt added?
9. Why and how is butter "worked"?
10. What are the advantages and disadvantages of the earthen jar and the one-pound print as forms of packing for market?
11. How may difficult churning on the farm in winter be overcome?
12. What is meant by overrun in butter making?
13. Under what conditions will unsalted butter keep as well as salted?
14. What causes light-colored streaks or wavy marbling in butter?
15. Upon what points is butter scored?

CHAPTER XXXII

TESTS NECESSARY IN CREAMERIES

The butter fat test is naturally the most important (Chapter XXVIII, yet the proper conduct of any creamery includes several others as well (Fig. 121).

The acid test is a method of determining the quantity of acid in or degree of sourness of a cream by the use of an alkali solution. This is made by dissolving 4 grams of caustic (KOH) in 1000 c.c. pure water. This is a simple titration of an alkali solution of known strength against a known amount of sour cream of unknown acid strength in the presence of phenolphthalein as an indicator, two or three drops being used. So long as the mixture of cream and alkali solution remains white the acid is in excess. When the acid is killed the whole mixture turns pink. If 17.6 c.c. of cream be taken as sample a normal acidity would require the use of about 12 c.c. of the alkali solution, which would indicate the presence of about 0.61 per cent acid. The formula usually employed in the determination of acid is that devised by Dr. Manns:

$$\frac{\text{c.c. alkali} \times .009}{\text{c.c. sample used}} \times 100 = \text{per cent of acid.}$$

The lime water test for acid is cheaper and easier of operation than the Manns and sufficiently accurate when used on sour creams. The lime water is made by putting a quantity of quick or air-slacked lime in any convenient jar, covering with water, stirring and letting stand for sixty hours or more in order that the water shall have taken up all the lime possible. When the solution has reached its condition of constant strength the clear liquid should be poured or drawn off into a separate bottle and more water added to the lime and stirred for a later usage. To make the test 17.6 c.c. of sour cream are then measured into a

white cup and the rinsings of the pipette added to the cream in the cup. Three or four drops of phenolphthalein indicator are then added to the sample. The lime water is then added from a graduated cylinder or a burette until a delicate permanent pink color is reached. So long as the mixture remains colorless, acid

FIG. 121.—Dairy School students checking up their work by means of the Babcock test.

predominates. When a constant pink color appears it may be judged that the free acid has been destroyed by the lime water. The quantity of lime water used may then be read from the cylinder. The amount of acid in the cream will be indicated by

dividing the number of cubic centimeters of lime water required for neutralization by 5. Thus:

$$\frac{\text{c.c. lime water}}{5} \times \frac{1}{10} = \text{per cent of acid.}$$

Thus, if a cream be so sour as to require 30 c.c. of saturated lime water to neutralize the acid in 17.6 c.c. of cream, we have $\frac{30}{5} = 6$, or 0.60 per cent acid. The lime water test will not work on sweet milk or cheese making, but is of value in farm or creamery butter making.

The moisture test is used to determine the amount of moisture in finished butter and its use is highly important, especially in preventing the incorporation of an illegal quantity of water. Butter must contain some water to dissolve the salt and to prevent an oily taste. This is accomplished by about 14 or 15 per cent moisture. The law in many states and a ruling of the Internal Revenue Department of the Federal Government make a butter illegal if it contains 16 per cent or more of moisture.

The test is made by warming a carefully taken sample and mixing it into a paste and then carefully weighing out into an aluminum cup 10 grams or 20 grams, according to test used. The sample is then heated slowly over an alcohol lamp or other flame until the water is entirely expelled from the sample. The complete absence of moisture is indicated by a slight browning of the sample. The sample is then re-weighed. The percentage amount of water originally present is shown by the percentage amount of loss occasioned by drying. The apparatus for making this test is not expensive and it is highly important that it be used regularly in creamery butter-making.

Salt Test.—The salt test now usually employed is that devised by Mr. Gray of the Federal Dairy Division. The solution used is one made by dissolving 5.81 grams silver nitrate in 2000 c.c. pure water. The indicator used is potassium chromate. Ten grams of butter to be tested are weighed into a flask, dissolved in hot water and made up to 500 c.c., 50 c.c. of this solution is then pipetted out and discharged into

a white porcelain or enamel vessel. Two or three drops of potassium chromate indicator are then added to the solution. The silver nitrate solution is then added from a burette until the sample assumes a reddish-brown color. Each c.c. of silver nitrate solution used will represent 0.1 per cent of salt. Thus 25.5 c.c. of solution used would indicate the presence of 2.55 per cent salt in the sample. The use of a salt test is essential to uniformity of product.

QUESTIONS

1. What is the purpose of the acid test in butter making?
2. How is it operated?
3. How may lime water be used in the place of other neutralizers?
4. How is the test for moisture in butter operated?
5. Explain the use of the salt test.

CHAPTER XXXIII

FARM DAIRY CHEESE (GOUDA)[1]

There are sold in America probably a hundred or more varieties of cheese. Although by far the greater portion, with respect to quantity, is made here, the manifold kinds are largely imported from Europe, chiefly from Switzerland, Italy, France and Germany.

All cheese may be divided into two great classes, that made from fresh sweet milk and that made from milk which has become, or is made to become, slightly acid. The American cheese, commonly sold simply as cheese, is of the acid curd kind, while most of the imported cheeses are of the sweet curd group. The Gouda is of Holland origin and is one of the sweet curd cheeses. It is, therefore, more closely related to the Brick and the Swiss than to our common cheese.

The ordinary process by which our American cheese is made in factories is not applicable to farm dairy cheese making, because it requires too much time, and is so complicated that it requires years of practice to become sufficiently familiar with the varying conditions in which milk comes to the vat.

Process of Making.—The various changes that take place in milk nearly all develop in the milk drawn in the evening and kept over until the following morning. So if milk is made into cheese immediately after it is drawn, no difficulty will be experienced, and by employing a simple and short method of manufacture, anyone at all accustomed to handling milk can make a uniformly good cheese with the appliances found in any well-regulated farm home.

The best time to make farm dairy cheese is immediately after milking. The milk should first be poured from one vessel to another in some locality where the air is pure and fresh, raising the vessel from which the milk is poured high, so the

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[1] Adapted in part from Minnesota Circular, "Farm Dairy Cheese."

air can pass through the milk and carry off the animal odor. The milk is then poured into the vat, or if no vat is available a large wash boiler may be used. It is not necessary to use cheese color, but if it is desired that the cheese look rich about a teaspoonful of cheese color to sixteen gallons of milk may be used. The color is best mixed by means of a large dipper, filling it half full of milk, mixing the color thoroughly in it and stirring it into the milk.

At this point the milk is heated, if necessary, to make certain it has a temperature of 86 to 89 degrees. It may be heated by setting it on the stove for a short time, stirring continually. Hot water must not be added to warm milk, it retards greatly the rennet action. The rennet extract at the rate of one ounce to a hundred pounds or twelve gallons of milk is now added. It should first have been diluted in about ten times its bulk of cold water before adding. It must be well stirred into the milk. The milk should begin to curdle in from ten to twelve minutes.

If rennet tablets are used to curdle the milk it is best to use one small tablet for every five gallons of milk, or one large tablet to twenty-five gallons of milk. Small tablets are about the size of a dime; large tablets are about the size of a silver quarter of a dollar. The rennet may be procured from any creamery supply house.

To add the rennet, if tablets are used, the required amount is first dissolved in a small quantity of cold water and then poured into the milk. Great care should be taken not to have the milk at a temperature below 86 degrees when the rennet is put in, and it should not be above 90 degrees afterward. The milk must now be stirred gently for two or three minutes, then let stand until the curd is firm enough to cut. To ascertain when the curd is ready for cutting the index finger is inserted into the milk at an angle of forty-five degrees until the thumb nail touches the milk, a slight notch is then made in the curd with the thumb, then the finger is gently raised; if the curd breaks clean across it without many flakes remaining on the finger it is ready for cutting. With a little practice one will soon know when the curd mass is ready to cut.

For cutting, regular cheese knives are best, one with horizontal blades and one with perpendicular blades. In case it is intended to make only a few cheeses a wire bread toaster or a coil of clean hay wire may be used, the wires being about half an inch apart. The cut is first made lengthwise, then crosswise of the vat or boiler until the curd is cut into cubes about the size of small kernels of corn.

After the cutting is finished the curd is gently stirred by hand for about three minutes, then heated slowly to 98 or 100 degrees, constantly stirring gently while the curd is being heated; the curd is kept at this temperature for about forty minutes. To tell when the curd is sufficiently cooked a handful is squeezed gently, held for a moment, then the hand is opened and if the curd falls apart it is firm enough. As soon as the curd is sufficiently cooked the whey is drawn off and the mold is filled by taking a double handful at a time and pressing gently into the mold, continuing until the mold is full and well rounded up.

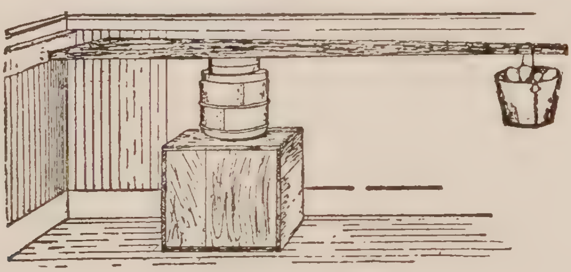

FIG. 122.—A simple cheese press for farm dairy cheese making.

The cheese curd is then taken out of the mold and turned upside down and replaced The cover is put on and the whole is put into the press, which may be a simple, old-fashioned lever press, illustrated in the accompanying cut (Fig. 122). The stick should be about twelve feet long. A broken wagon tongue or fence rail answers the purpose very well. A pail containing a few cobble stones will answer for a weight. Regular Gouda molds are best, but any tin or wooden receptacle will answer if small holes are made in it to permit the whey to escape. The cheese should be from eight to ten inches in diameter and about three or four inches high. The box upon which the mold is to be placed is set about three feet from a wall, post or tree on

which a slat is nailed, under which the end of the stick is placed. A board block about six inches in diameter is set on the mold, on this the stick is rested. Full pressure is not applied at first, but the pail is hung about half way between the mold and the end of the stick. The cheese remains a few hours in the press and is then taken out and dressed.

To dress a cheese it is first put into warm water and a piece of cheesecloth about six inches wide and long enough to go around the cheese is wrapped smoothly around the cheese and folded down over the sides; then a cap is put on each side. The cheese is then returned to the mold. Both are put under the press, moving the pail to the end of the stick. The cheese is left in the press for about twelve hours, then taken out and salted.

The cheese may be either dry-salted or brine-salted. Brine-salting is the better way. A solution of salt and water is made as strong as it can possibly be made; the cheese is put in this and salt is sprinkled on the exposed surface. The cheese is left in this for forty-eight hours, being turned every twelve hours. When salted sufficiently long the cheese should be removed from the brine, stripped of cloths, wiped dry and laid on a cellar shelf. After about two or three days, when the cheese has become fairly dry on the outside, it should be dipped in hot paraffin. This is done to kill all mold spores that have lodged on the moist surface and also to keep the cheese moist by preventing the evaporation of water.

The temperature best adapted for curing is from 55 to 65 degrees. The cheese will be ready for use in from two to four months. The lighter the cheese is salted the sooner will it be ready for use, and the more the curd is cooked the slower it will be in ripening and the longer it will keep.

Yield, Cost and Value.—Cheese removes from the milk most of the casein and fat but practically none of the sugar and albumen. Yet a yield of cheese equal to about 10 per cent of the weight of the milk may be expected, because in the cheese there must and will be some water. A hundred pounds of milk testing 3.7 per cent fat will yield about 10 pounds of cheese. The butter value of the milk at 30 cents per pound for fat would be

about $1.11 and the skim milk about 20 cents more, making a total of about $1.30 per hundred. The 10 pounds of cheese would be worth, if purchased, about 25 cents per pound or $2.50, and the whey about 10 cents more, making about $2.60; or, in other words, the cheese for the farm home may be made at home for less than half the usual retail price.

A gallon of milk weighs about 8.6 pounds and will make about 0.85 pound of cheese. Therefore, to make a cheese weighing from six to seven pounds, seven to eight gallons of milk will be required. Home-made Gouda has a food value equal to American cheese and greater than many imported varieties. With a little experience cheese may be made during May and October to supply the table the year around.

QUESTIONS

1. To what class of cheese does the Gouda belong?
2. How many pounds of cheese will eight gallons of milk make?
3. At butter prices for fat in milk what will farm-made cheese cost per pound?
4. How may a constant supply for the home table be most conveniently made?
5. Why is cheese not more generally made on farms?

CHAPTER XXXIV

COTTAGE CHEESE

Food Value—Cost.—Cottage cheese, made from skim milk, is one of the most healthful and economical as well as tasty foods which can be provided for the farm table. The usually calculated value of skim milk for stock feeding is about 25 cents a hundred. One hundred pounds of skim milk will produce from 12 to 14 pounds of cottage cheese, thus entailing a cost of about 2 cents per pound. While such cheese is about two-thirds water, which would advance the cost of the solid substances eaten to about 6 cents per pound, it must not be forgotten that ordinary meat costing from 15 to 25 cents per pound is likewise about two-thirds water; also that even at 6 cents per pound for the solid substance of cottage cheese the fact that it is rich in protein, making for muscular growth, gives it, in reality, a higher value than cereals which could be bought at the same price per pound.

Method of Making.—The making of cottage cheese or pot cheese, though simple, is controlled by certain principles which make for quality. Flavor is the quality first to be considered. This can be controlled only by governing the character of the milk used. While not a very sensitive product cottage cheese is the most tasty when clean sweet milk is properly soured at a temperature of about 70 to 75 degrees F. A higher temperature, one ranging in the neighborhood of 90 degrees, is liable to produce gassy fermentations and foul odors, and a temperature lower than 70 degrees retards the growth of the bacteria which produce the acid, and thus causes a waste of time, and if too cold the souring process can scarcely continue at all. At times, too, it is necessary to add to the skim milk to be soured a little starter in the nature of clean, sharp buttermilk or a small quantity of plain milk which has previously become sour. If the milk becomes too sour the tendency is to produce a hard, dry, sawdust-like product, one not usually relished. When the milk has

curdled, not too thick, it should be cut into little squares or cubes by means of an ordinary knife or a wire bread toaster may be used if a larger quantity is being produced. This done, the temperature of the entire mass should be raised, either by heating on the stove or by pouring hot water into the curd mass. This is done for the purpose of "cooking" or hardening the curd. Water should not be added when the heating can be done the other way, as it removes flavor. The temperature should be raised slowly with frequent stirring until a temperature of from 95 to 98 degrees has been reached. The lower temperature to be used would be with very sour milk, the higher with milk not so sour. If, however, the milk is really not sour enough when the heating is done it will produce a rubbery mass, one not usually favored. The effect of high acid is to produce dry hard curd; the effect of high heat is to produce rubbery curd; the effect of long-continued heat is to produce a hard curd. The total time of cooking will require from twenty-five to forty minutes. At this point experience only can indicate just when to stop the cooking process. The curd should be fairly firm but not hard. The whey is removed most easily by pouring the entire mass into a cheesecloth bag, and permitting it to hang until thoroughly drained. If more rapid work is desired a press, such as used for extracting cider from apples or fat from suet, will be found serviceable.

Finishing.—After the moisture has been fairly well, but not wholly drained or pressed out, the curd may be thoroughly worked up by means of a ladle, or if rather firm, by hand. Many, however, prefer that the curd remain in large flakes and lumps rather than in fine form, in which case the curd should be cut in large squares, stirred carefully, and mixed with a silver fork gently. During this mixing process the salt should be added, and if desired, a small quantity of pepper, preferably white pepper. At this point cream may be added to further increase the tasty quality and food value of the cheese. When thoroughly mixed to an even consistency it may be made up into little patty-cake balls by rolling in the hands or, if desired especially for market, may be printed the same as butter into pound prints, and

wrapped in parchment or paraffin paper to prevent its drying too rapidly. In this form it may or may not, according to the local demands, be inserted into a paraffined butter carton, where it will preserve its quality for a somewhat longer time than if left more or less exposed.

Short Lived.—Cottage cheese is short lived. For best results it should be consumed the same day that it is made. If held, it should be in a cold refrigerator to prevent excessive souring, and even under favorable conditions, cannot be expected to retain its quality longer than from two to four days.

Skim milk will yield from 12 to 14 pounds of cottage cheese per hundred pounds of milk, and when the cheese is seasoned, and a small quantity of cream added, and when put on the market in attractive form, usually brings 10 cents per pound.

Farmers' wives generally should make more use of cottage cheese on their home tables and some are so situated that they could earn nice pin money by putting a tasty cheese on the local market.

QUESTIONS

1. What is the food value and cost per pound of cottage cheese?
2. What is the effect of high acid on condition of curd?
3. What is the effect of high temperature on texture of finished cheese?
4. How long will cottage cheese keep its quality if kept cold?

CHAPTER XXXV

ICE CREAM

Ice cream is one of the most universally favored desserts in America. It is sold in most candy, fruit and drug stores and served at practically all hotels in this country, yet is little known in most European cities. The ocean liners serve ice cream to the passengers in all parts of the world, yet the ice cream is practically all secured in the United States and stored even for months on the vessel. Ice cream likewise is a favorite dish in the home, where large quantities are made in small lots.

Artificial cooling in a simple way has been known for centuries and the making of a frozen food somewhat resembling our ice cream has been practiced for several hundred years. But the ice cream industry as known to-day started in 1852 in Baltimore.

The making of ice cream and shipping it even long distances is now a well-organized industry which consumes about 50,000,000 pounds of butter fat annually.

The formula used is important, but little more so than the method of freezing and storing. For best results there should not be to exceed 14¼ per cent sugar in the finished article. This is attained by adding one part sugar for every six parts of liquid or one pint sugar to three quarts cream, for a six-quart freezer. For a gallon freezer the following formula has been found good:

Rich Formula	*Children's Formula*
2 qts. 20 per cent cream	1 qt. 20 per cent cream
⅔ pint sugar	1 qt. skim milk
Vanilla to taste	⅔ pint sugar
	Vanilla to taste.

If eggs are used the whole mass should be cooked into a custard. This produces a very rich tasting dish but one that is rather expensive. In general commercial trade no eggs are used. If chocolate, coffee, or caramel flavors are desired in

addition, these flavors may be added on top of the vanilla with no ill effects, in fact chocolate ice cream is better if there be some vanilla present.

Condensed milk is coming to be very much used in ice cream to give body and smoothness. For home Sunday dinners it might not be worth while to use condensed milk, but for any more formal occasion where continued trade is sought it certainly does not pay to do without it.

The addition of more fat, *i.e.,* richer cream, will not take the place of the smooth body of condensed milk. If the sweetened variety is used allowance must be made for the sugar in it. If the unsweetened, sterilized, canned kind be used, care needs be taken to use not over 10 to 15 per cent of it, lest the cooked taste be too pronounced. If condensed milk be used it should take the place of an equal amount of cream so that the sugar proportion will remain constant.

Formula With Condensed Milk

1 qt. 20 per cent cream
1½ pints whole milk
½ pint condensed milk.
²/₃ pint sugar
Vanilla to taste.

This will produce a smooth ice cream which will test about 12 or 13 per cent fat and have better body and standing-up ability than when no condensed milk is used.

Ice cream powders are in most cases simply mixtures in various proportions of some East Indian gum with powdered sugar. Rice flour and starch are sometimes used, but are not to be recommended. This powder is used by first being thoroughly mixed with the dry sugar and later the sugar mixture is beaten into the cream. In this way the powder helps to "dry out" the ice cream and cause it to remain in mass form.

Gelatin is now used in nearly all commercial ice creams to prevent the formation of coarse spines or slivers of ice when the cream stands a few days. It is used by first dissolving it in hot water and pouring into the cream while hot, stirring vigorously

the while. A teaspoonful of any table gelatin dissolved in half a cup of water will suffice for a gallon of ice cream.

Gum tragacanth, a vegetable gum, is used but is not as strong to prevent crystallization as gelatin and is more used to dry out the mix, to produce a compact meaty mass. This is used in the form of a dry powder, preferably mixed with finely powdered sugar to aid distribution.

The freezing of ice cream is an easy matter provided too much sugar has not been used. Water freezes at 32 degrees F., milk and cream at 31 degrees, and cream in which 14 per cent sugar has been dissolved, at 28 degrees. If more sugar be added the freezing temperature will be yet more depressed. Water-ice and sherbets freeze with more difficulty than ice creams because carrying more sugar.

The best simple trick in the matter of quick and easy freezing is to *pour cold water* in among the ice lumps and salt grains *before starting* to turn (Fig. 123).

When the mix is in the freezer can and all is adjusted, cracked ice should be added to the freezer tub first, until about one-third full, salt is then scattered over the ice, more ice is then added to fill the tub nearly full, and salt again scattered on top of the ice. The ice should not be packed about the can. At this point in the process the cold water is added until it flows out the safety hole on the side. The first thing noticed as a result of adding the water is that it will turn much easier than without it, and second, it will freeze in a fraction of the time often required in the dry ice-salt method. Moreover, since the mix is comparatively warm when added and must be cooled to about 30 to 29 degrees before the swell can take place, it is useless to turn rapidly at first. Butter lumps are formed by turning too fast at first and churning it. The freezing process may even be done on time schedule. During the first seven minutes after the water has been added the freezer crank should be turned rapidly, two or three revolutions, every half-minute to keep the walls clear and prevent the dasher from setting. After seven minutes of cooling the mix will be nearly ready to freeze and will be cool enough to be viscid. In this condition it will

retain a part of the air beaten into it by the rapid turning which continues from the seventh minute until the ice cream is frozen. The whole process of freezing with water as described will not take more than twelve or thirteen minutes and may be done in ten minutes with a one- or two-gallon freezer and in thirteen minutes with a ten-gallon freezer.

The quantity of salt to use to get quick freezing need not be more than one-tenth of the amount of ice. Full value of the salt is secured by putting it at the middle and at the top of the ice so it will work on the ice as it trickles downward.

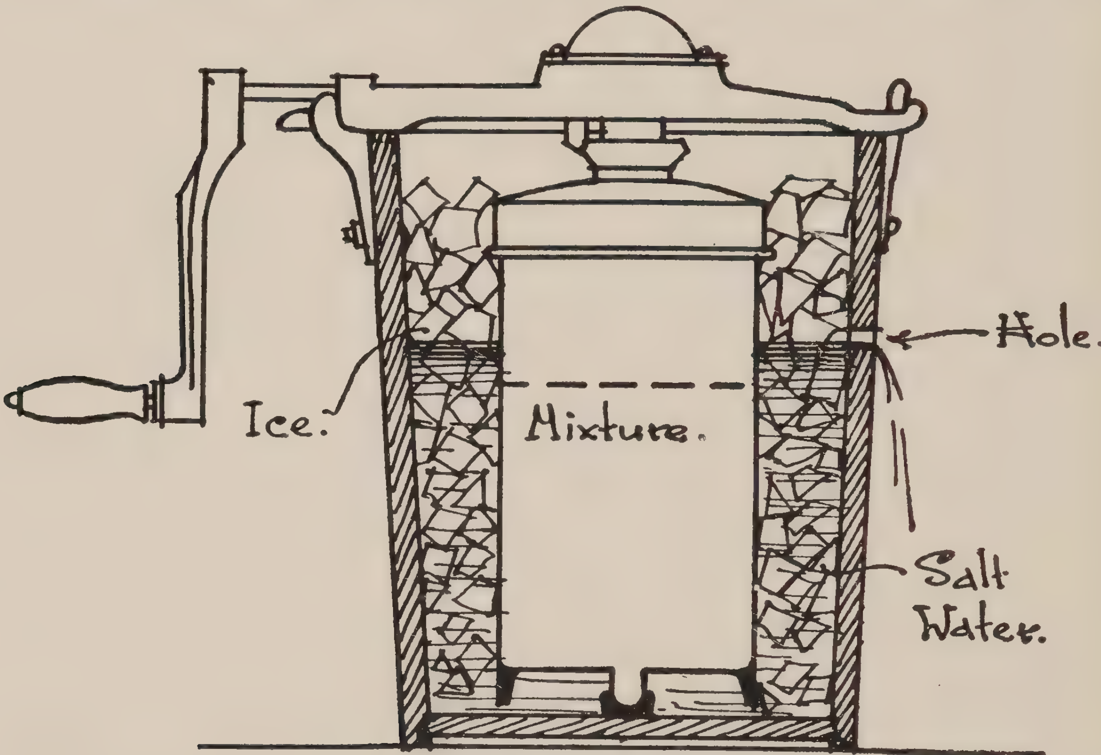

FIG. 123.—Illustrating the addition of water to the salt ice mixture to hasten the freezing of the ice cream.

To freeze ice cream in ten minutes be sure the mix is not too sweet and then pour cold water in among the lumps of ice.

Holding ice cream is best done by packing solid in can and then dry-packing the can, using a coarse salt that will not dissolve too rapidly. If for any reason the ice cream melts and then is rehardened without agitation it will not be edible on account of spines of ice which have formed. Melting and refreezing is the cause of coarse spiny ice cream. The whole mass may be put into a freezer and refrozen, however.

If several batches are to be frozen in quick succession the holding can should be well packed in ice and salt in advance. A common "shot-gun" milk can set in a tub or half barrel makes a very good holding can. By transferring the freshly made batch to the iced can any desired amount may be made even with a small freezer.

The "swell" in ice cream is due to the incorporation of air into the cream just as in whipped cream or beaten egg. A good swell is 100 per cent, based on the cream, *i.e.,* not considering the sugar, or 85 per cent based on the volume of total mix. A better way is to figure by weight. A gallon of market ice cream should not weigh over 5.2 pounds to the gallon, and 5 pounds is enough for quality and profit.

QUESTIONS

1. How much ice cream is consumed per capita in the United States annually?
2. How long has ice cream making been carried on in a wholesale way?
3. Why and how is condensed milk used in ice cream making?
4. Why and how are ice cream powders used?
5. Why and how is gelatin used?
6. How may ice cream be frozen in ten to twelve minutes with a 1 to 10 use of salt and ice?
7. How may the ice cream made be best stored while more is being frozen?
8. Why is a reasonable "swell" desirable in ice cream?

PART VII

MARKET MILK

CHAPTER XXXVI

MARKET MILK

By market milk is meant that milk which is consumed in the form of milk, chiefly in cities and towns.

The importance of this phase of the dairy industry has not been fully appreciated by the producers of milk, by the consumers, or by the state institutions giving instruction in the various phases of dairy husbandry. From government figures it appears that one-third of all the milk produced by the nearly twenty-two million dairy cows in the United States, is sent to town to be used as milk, cream or condensed milk, the remaining two-thirds being made into butter (58 per cent) or cheese (8 per cent). Just what portion of the third used as market milk is sold as cream and what portion as milk has not been shown, but from figures at hand it would seem that more than half of the fat sold in the two has been sold in milk. Consequently, therefore, about 20 per cent of the total milk flow finds its way to the consumer as milk. Although this quantity would give to each individual less than a quart a day it is well known that adults, as a rule, consume small quantities of milk, and that the major portion purchased in homes is used as food for infants and young children. In this connection it is more than of interest to note that fully two-thirds of the 2,250,000 infants in the United States, or 1,500,000, are being raised wholly, or very largely, upon the milk of the cow rather than at the breast. The likelihood of death during the first year of infants so reared is also known to be about nine times as great as those nourished on mother's milk. It is evident, therefore, that the proper production, care and use of the 20 per cent used as infant food is of more vital consequence than the remaining 80 per cent which is being consumed by adults as cream, butter or cheese. Since this minor quantity is of major value, measured in consequences, every milk producer should know more exactly what the consequences of inferior milk are. It has been demonstrated that

where milk can be secured clean, fresh and from healthy cows the mortality rate drops to about two to one, showing conclusively that it is not cow's milk *per se,* but rather the condition of the cow's milk which causes the trouble.

Factors Influencing Quality.—Practically all unfavorable conditions or qualities of milk can be related to one of the following causes:

A. The Cow May be Sick.—If she is, her milk should be considered as also out of condition and undesirable as human food. Green corn fed in excessive amounts in late summer or early autumn will induce looseness on the part of the cow, which condition will be promptly reflected in the child consuming the milk. On the other hand, dry hay and fodder which bring about a constipated condition in the cow tend to induce similar condition on the part of the child. Some feeds such as corn silage made from mature corn or roots should be fed to cows in winter from which milk is sold for infant feeding, since these feeds tend strongly to keep the cow in best physical condition.

B. Strong flavored feeds, such as rye or winter wheat pasture or the various wild weeds that spring up in spring or autumn in various places, also produce a milk of inferior flavor, though not particularly detrimental if consumed.

C. Air which contains foul odors of any sort may be the source of disagreeable flavors in milk. Milk, therefore, should be removed from the stable promptly and kept in a sweet, fresh atmosphere, in the milk house. This class of trouble is, however, of small consequence compared with the condition of the cow and especially when compared with the detrimental effects of bacteria.

D. Bacteria are microscopic plants which grow under a great variety of conditions all about us. By far the greater number are of no consequence to us so far as our health is concerned (Fig. 124). Milk produced in the winter time in the ordinary stable may contain a dozen or two varieties of bacteria, yet only two or three kinds will be found present capable of modifying the milk itself to any appreciable degree. The universally common milk organism is the bacillus which produces lactic acid.

This is particularly true in summer when the cows are on pasture. This germ does not produce heat-resisting spores and is therefore easily killed by high temperature. Although this organism is the one which sours milk and is so abundant in buttermilk, which is a good beverage for both adults and infants, it does not follow that a medium number in milk supposed to be sweet would be beneficial to the child. Milk fed to young animals, whether child, chicken, pig or calf, should be thoroughly sweet or fully sour.

The second most common class of bacteria found in milk is that known as the Colon group, "Bacilli Coli." There are

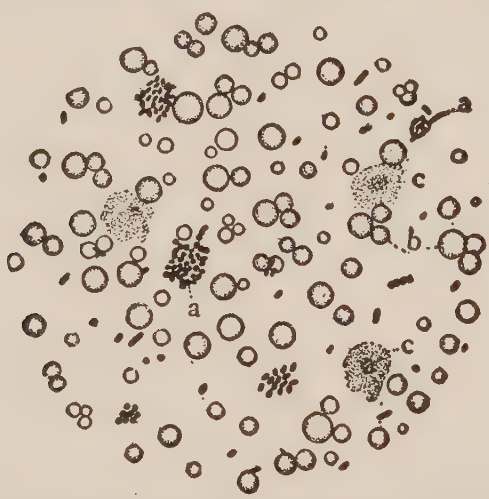

FIG. 124.—Milk as it appears under the microscope. The clear, round fat globules are interspersed with bacteria. Note relative smallness of the germs, also that the bacteria are grouped in clusters.

several varieties of this class of organisms. Some have power of free movement, others have not, however none of them have the power of forming within themselves spores so resistant to heat that even boiling may not destroy them. They also produce gas while growing. It is the distending effect of the gas produced by the growth of these bacteria which causes the pain to infants suffering from cholera infantum and similar intestinal disturbances. The natural habitat or home of this class of bacteria is the intestinal tract of all higher animals, especially cows, and they gain entrance into the milk through particles of manure which accidentally fall into the pail during milking. Many other methods of entrance are possible, *e.g.*, from poorly washed pails, or even nursing bottle and nipple.

Ropy or stringy milk, if not in this condition when drawn from the cow, in which case garget would be indicated, is also the work of certain microscopic plants which feed largely upon the sugar of the milk and reduce it to the ropy or stringy character. This complaint is most common in the warm weather of summer while cows are standing in stagnant pools of water in the pasture. Ropy milk is not particularly injurious, but

Score Card for Milk

United States Department of Agriculture, Bureau of Animal Industry, Dairy Division.

Place..

Class..........................*Exhibit No*..........................

ITEM.	PERFECT SCORE.	SCORE ALLOWED.	REMARKS.
Bacteria................	35	....	Bacteria found per cubic centimeter ....
Flavor and odor.........	25	....	Cowy, Bitter, Feed, Flat, Strong, ...
Visible dirt............	10	....	....
Fat.....................	10	....	Per cent found ....
Solids not fat..........	10	....	Per cent found ....
Acidity.................	5	....	Per cent found ....
Bottle and cap..........	5	....	Cap....................... Bottle....................
Total..............	100	....	

Exhibitor,..

Address,..

(*Signed*)..
Judge.

Date,.............................., 19

Directions for Scoring.

BACTERIA PER CUBIC CENTIMETER—PERFECT SCORE, 35.

	Points		Points
Under 500	35.0	25,001– 30,000	29.0
500– 1,000	34.9	30,001– 35,000	28.0
1,001– 1,500	34.8	35,001– 40,000	27.0
1,501– 2,000	34.7	40,001– 45,000	26.0
2,001– 2,500	34.6	45,001– 50,000	25.0
2,501– 3,000	34.5	50,001– 55,000	24.0
3,001– 3,500	34.4	55,001– 60,000	23.0
3,501– 4,000	34.3	60,001– 65.000	22.0
4,001– 5,000	34.0	65,001– 70,000	21.0
5,001– 6,000	33.8	70,001– 75,000	20.0
6,001– 7,000	33.6	75,001– 80,000	19.0
7,001– 8,000	33.4	80,001– 85,000	18.0
8,001– 9,000	33.2	85,001– 90,000	17.0
9,001–10,000	33.0	90,001– 95,000	16.0
10,001–11,000	32.8	95,001–100,000	15.0
11,001–12,000	32.6	100,001–120,000	12.5
12,001–13,000	32.4	120,001–140,000	10.0
13,001–14,000	32.2	140,001–160,000	7.5
14,001–15,000	32.0	160,001–180,000	5.0
15,001–20,000	31.0	180,001–200,000	2.5
20,001–25,000	30.0	Above 200,000	0.0

NOTE.—When the number of bacteria per cubic centimeter exceeds the local legal limit the score shall be 0.

FLAVOR AND ODOR—PERFECT SCORE, 25.

Deductions for disagreeable or foreign odor or flavor should be made according to conditions found. When possible to recognize the cause of the difficulty it should be described under Remarks.

VISIBLE DIRT—PERFECT SCORE, 10.

Examination for visible dirt should be made only after the milk has stood for some time undisturbed in any way. Raise the bottle carefully in its natural, upright position, without tipping, until higher than the head. Observe the bottom of the milk with the naked eye or by the aid of a reading glass. The presence of the slightest movable speck makes a perfect score impossible. Further deductions should be made according to the amount of dirt found. When possible the nature of the dirt should be described under Remarks.

FAT IN MILK—PERFECT SCORE, 10.

	Points		Points
4.0 per cent and over	10	3.2 per cent	6
3.9 per cent	9.8	3.1 per cent	5
3.8 per cent	9.6	3.0 per cent	4
3.7 per cent	9.4	2.9 per cent	3
3.6 per cent	9.2	2.8 per cent	2
3.5 per cent	9	2.7 per cent	1
3.4 per cent	8	Less than 2.7 per cent	0
3.3 per cent	7		

NOTE.—When the per cent of fat is less than the local legal limit the score shall be 0.

SOLIDS NOT FAT—PERFECT SCORE, 10.

	Points		Points
8.7 per cent. and over	10	8.1 per cent	4
8.6 per cent	9	8.0 per cent	3
8.5 per cent	8	7.9 per cent	2
8.4 per cent	7	7.8 per cent	1
8.3 per cent	6	Less than 7.8 per cent	0
8.2 per cent	5		

NOTE.—When the per cent of solids not fat is less than the local legal limit the score shall be 0.

ACIDITY—PERFECT SCORE, 5.

	Points		Points
0.2 per cent and less	5	0.23 per cent	2
0.21 per cent	4	0.24 per cent	1
0.22 per cent	3	Over 0.24 per cent	0

BOTTLE AND CAP—PERFECT SCORE, 5.

Bottles should be made of clear glass and free from attached metal parts. Caps should be sealed in their place with hot paraffin, or both cap and top of bottle covered with parchment paper or other protection against water and dirt. Deduct for tinted glass, attached metal parts, unprotected or leaky caps, partially filled bottles, or other conditions permitting contamination of milk or detracting from the appearance of the package.

the ropy condition is usually accompanied by a bitter or foul flavor.

Bitter milk may be either the result of certain bacteria which grow slowly at a temperature of between 40 and 50 degrees, or it may be due to the physical condition of the cow yielding it, in which case the bitter taste will be evident the moment it is drawn from the udder. This condition often occurs with cows that are being overfed on rich protein feeds.

All that has been said or intimated with regard to the effects of dirt germs in the baby's milk holds just as true respecting the germs that gain access from a dirty nursing bottle or nipple as from the dirty tools of the milkman. Dairymen are often blamed when carelessness in the consumer's own home is the source of the trouble. A bottle of milk, if set into a pail of water in which a chunk of ice is kept floating and the whole set into the refrigerator, will keep sweet two or three times as long as it will if set merely in the cool air of the same ice chest.

QUESTIONS

1. What is meant by market milk?
2. What per cent of the total amount of milk produced is used as butter, as cheese, as milk and cream?
3. How many babies are there in the United States under one year of age?
4. What per cent and number are bottle fed?
5. About what is the proportion of infant mortality between the breast fed and the cow's milk fed?
6. What three classes of factors influence the quality of cow's milk?
7. How is milk scored?

CHAPTER XXXVII

THE ADULTERATION OF MILK

Because milk was for so long a time sold by the measure, with no easy, accurate way of testing for quality, it is not surprising that some men either skimmed or watered the milk they sold. Of all forms of adulteration these two are most common and in general most easily detected.

Chemical analysis of the milk to detect adulterations is not necessary since it has been discovered that the specific gravity (weight per volume) of milk bears a definite and constant relation to the amount of solids contained in it.

The Quevenne lactometer, which is the chief instrument used in the detection of skimming or watering, is a glass tube filled with air, weighted to float in milk, and graduated to indicate the depth to which it sinks. Since any floating object sinks until it displaces exactly its weight of liquid in which it is floating, the lighter or thinner the milk, the deeper the instrument will have to sink to balance.

Influence of Temperature.—Water, milk and most other liquids expand and become thinner or less dense upon becoming warm, consequently, the milk to be tested must be brought to a fixed temperature, 60 degrees or close to it. For every degree in temperature above 60, one-tenth is added to the lactometer reading; thus: if the lactometer, L = 31.5, at temperature 64, the corrected reading would be 31.9, and likewise for every degree below 60, one-tenth is subtracted from the lactometer reading, thus if L = 32.4 temperature 55, the correct reading would be 31.9. This rule for the correction does not hold true above 70 degrees nor below 50 degrees, and preferably should not be worked above 65 degrees nor below 55 degrees. The sample should be brought to within a few degrees of 60 before it is tested.

Influence of Air.—On account of the fine bubbles of air or other gas in freshly drawn milk, the lactometer cannot be ac-

curately used at once, but the milk should be held for about two or three hours to permit it to become of normal weight per volume.

Influence of Preservatives.—To keep milk test-samples from souring various chemicals are added to kill the bacteria and thereby preserve the sample. Corrosive sublimate or mercuric chloride is such heavy stuff that a single small tablet in one quart of milk will raise the lactometer reading higher than possible for even skim milk. A preservative such as formaldehyde is so nearly of the same weight as milk that it is preferable where specific gravity determinations are to be made.

The Use of the Lactometer (Fig. 125).—It has been found that the quantity of solids-not-fat is very nearly one-fourth the variable portion of the specific gravity figures. For example, the specific gravity of milk at 60 degrees varies from 1.029 with a naturally watery milk, to as high as 1.033 with a milk of a medium-testing Jersey, the average being about 1.032. It will be noted that the 1.0 portion of the figures is constant, while the 29–33 varies. Milk carries from 8 to 8.6 per cent solids-not-fat. The percentage amount of the non-fatty portion of milk is then but little more than one-fourth these variable figures. These figures, called lactometer reading, increase, therefore, four times as rapidly as the per cent of non-fatty solids. The fat in the milk also may be determined almost wholly by physical means, the Babcock test, rather than by true chemical anlysis.

Since fat has a specific gravity of 0.90 and skim milk or milk serum a specific gravity of 1.036 it follows that the less fat any given milk contains the heavier it becomes, and *vice versa.* Also since water weighs only 1.000 against milk 1.032, it follows that any addition of water to milk will lower its weight or specific gravity. Therefore, by combining the two, skim milk and water, it is possible to dilute a milk and still retain its natural specific gravity.

For this reason it is occasionally necessary to combine the use of fat test and the lactometer in order to detect adulteration. Thus, if the lactometer reading is higher than normal and

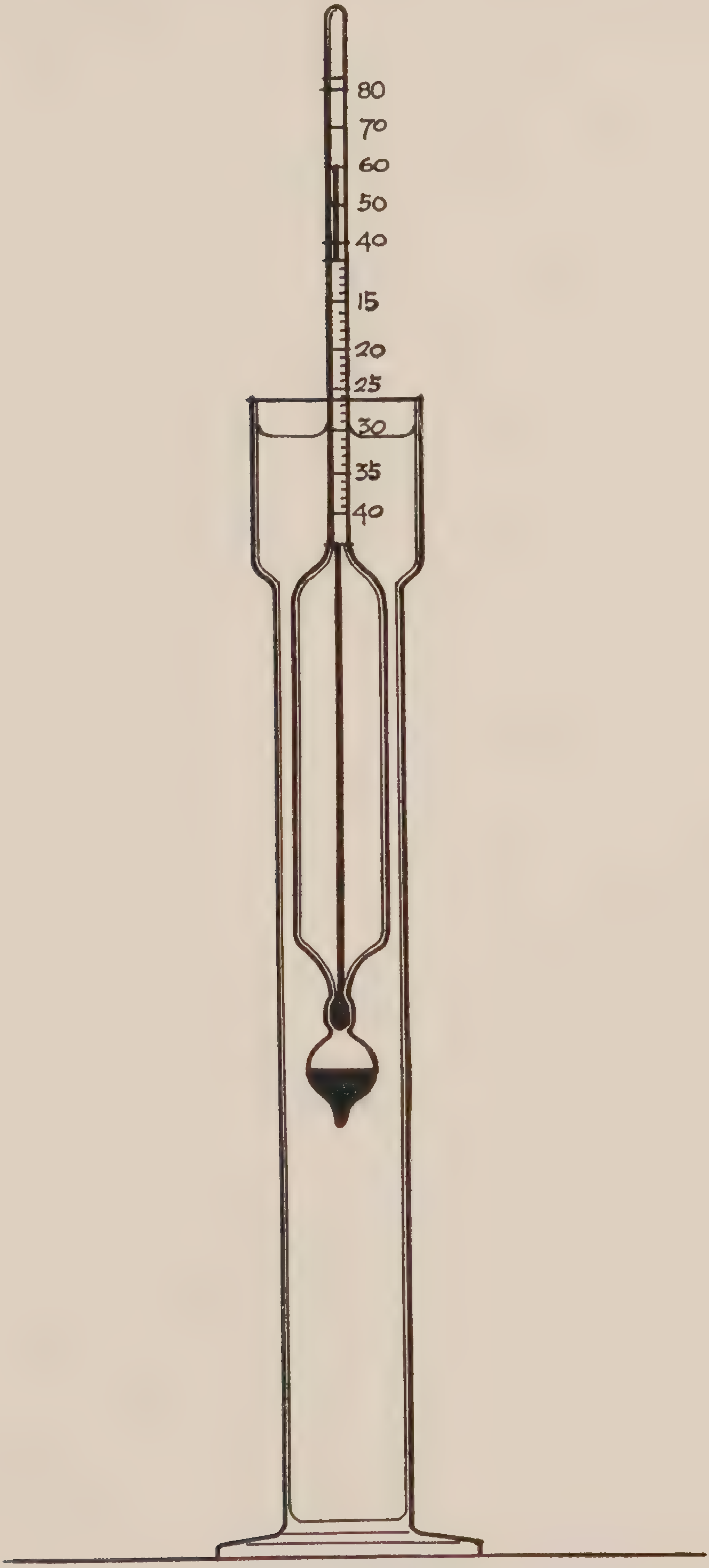

FIG. 125.—The lactometer is used for the detection of skimming and watering of milk. At temperature 60 degrees F. the lactometer will read about 31 or 32.

the fat test is lower than normal, the sample has been skimmed; while if the lactometer reading is low and the fat is low the sample has been watered, and again if the lactometer reading is normal and fat is low, the sample has been both skimmed and watered. Thus:

$$\left.\begin{array}{ll}\text{Lactometer} & \text{low}\\ \text{Fat} & \text{low}\end{array}\right\} = \text{watered}$$

$$\left.\begin{array}{ll}\text{Lactometer} & \text{high}\\ \text{Fat} & \text{low}\end{array}\right\} = \text{skimmed}$$

$$\left.\begin{array}{ll}\text{Lactometer} & \text{normal}\\ \text{Fat} & \text{low}\end{array}\right\} = \text{skimmed and watered}$$

The total food solids of milk may also be determined by the use of the lactometer and Babcock test by the application of the formula: Lactometer reading, divided by 4, plus two-tenths of the fat, equals solids-not-fat. This may be expressed thus:

$$\frac{L}{4} + 0.2\text{ f.} = \text{per cent solids-not-fat}$$

and

$$\frac{L}{4} + 1.2\text{ f.} = \text{per cent total solids}$$

Example: If $L = 31.9$, temperature 56, corrected $L = 31.5$. Then if the Babcock test for the sample reads 3.8 per cent fat we have: $\frac{31.5}{4} + .2 \times 3.8 = 8.64$ per cent solids-not-fat, and $8.64 + 3.8 = 12.44$ per cent total solids.

QUESTIONS

1. What is a lactometer?
2. What influence on its reading has temperature? Air and preservatives?
3. What preservative is most desirable when lactometer determinations are to be made? When fat only?
4. How may skimming and watering be detected?
5. How may the lactometer and fat test be used to determine the food content of milk?

CHAPTER XXXVIII

KINDS AND CLASSES OF MARKET MILK—METHODS OF SELLING

THE great need for a cleaner, more wholesome milk has focused the attention of many physicians, women's clubs, and dairymen to this substance, with the result that attempts are now being made in various ways, not only to produce some milk of vastly superior quality, but also to improve the quality of market milk in general.

The principal kinds as regards treatment or preparation are briefly described in this chapter.

"Loose" milk, so-called, is milk peddled about town in large cans from which the quantity desired by the consumer is dipped or drawn as needed. This term is used to distinguish it from bottled milk. Such bulk milk, sometimes called "dipped milk," may be just as clean and wholesome as any other. In smaller cities such is usually the case, but in larger centers the fact that milk can be sold loose somewhat more cheaply than bottled naturally develops a cheap milk industry in some quarter of the city. The inferior grades of milk are more likely to be turned off through this channel and if adulterants are used they are almost certain to be in such districts.

Bottled milk is sold in bottles (Fig. 126). It may be just as unfit as any other, but is more likely to have been produced in a cleaner manner and handled to preserve quality, since no one would willingly bestow attention, labor and the expense of bottling upon low-grade milk.

Clarified milk is milk which has been purified by having been passed through a centrifugal clarifier. This is a machine very similar to an ordinary cream separator through which milk is run for the purpose of abstracting from it the fine particles of dust which pass through even the good strainer, or any threads or clots of garget or blood, or any other foreign or undesirable matter. They are very effective in cleaning the

Fig. 126.—Milk bottles capped by four methods. The first at the left is the ordinary way. This capping collects dirt, while all the others keep all dirt outside. The capping methods shown in numbers 3, 4, 5, 6 are gaining favor rapidly. (Photo by Horton.)

milk and do not injure either the cream line or the condition of the fat globules. While, of course, it is preferable that the milk be produced and handled so cleanly that no such treatment shall be needed, it is a fact, nevertheless, that practically all milk would be benefited more or less by the use of such a machine.

Ordinary cream separators have often been used for this purpose by turning the cream and milk spouts to discharge into the same vessel, but though the "slime" removed is considerable, the machine devised for this particular purpose is more effective.

Standardized milk is milk to which cream or skim milk has been added for the purpose of bringing the fat content of the resultant mixture to the desired or required standard. Very often standardizing may be accomplished by merely mixing together the milk of the various breeds of cows. There is nothing ethically wrong with standardization and it should not be made illegal either by law or ruling. It is now practiced by practically all the larger city dairy companies. Those desiring to standardize the milk of a single herd may find the method explained in Chapter XXIX helpful.

Pasteurized milk is that which has been heated for the purpose of destroying whatever bacteria there are present in it.

Flash System.—When first introduced this system involved the heating of the milk to a temperature of about 166 degrees F., at which temperature it was held for a mere fraction of a minute, when it was immediately cooled to a temperature of about 40 degrees. Various machines were developed for the purpose of treating milk thus, despite the fact that the process was frowned upon by most physicians and public health workers. The milk itself, furthermore, was often not agreeable to the consumer, since the high temperature caused a slight caramelization of the milk sugar, thus changing the flavor slightly towards that of evaporated milk or boiled milk. The cream, too, did not rise quite as readily on such milk, thus causing many to feel that an insufficient amount of fat was present.

The Held System.—The new process of pasteurizing is to heat the milk to a temperature of about 145 degrees; to hold it at this temperature for about twenty-five minutes and then to cool quickly to about 40 degrees. By this means the cream line is not injured, the flavor is not changed and the bacteria are even more thoroughly destroyed than by the former system. This latter method is the one most largely employed at the present time.

The Bottle System.—A third method is to first bottle and cap the milk and then to immerse the bottles in warm water, then to raise the temperature of the tank of water to 145 degrees for fifty minutes to heat the milk. This method is better adapted to small dairies. It is not yet in general use.

Pasteurization of milk is no longer forbidden by health boards as was often the case a few years ago. On the contrary, practically all physicians now recommend it and many cities are compelling that milk shall have been pasteurized or shall have been produced by tested cows under inspected conditions before such milk shall be allowed to be sold within said city. Pasteurization, properly done, unquestionably improves the quality of the milk as it ordinarily comes to market and does not impair its nutritive properties in any way.

Sanitary milk is that produced by cows which have been examined and found free from tuberculosis and other disease and under conditions of cleanliness such as to insure a product containing not to exceed 100,000 bacteria per cubic centimeter. Such milk is considerably cleaner than the ordinary market milk before clarifying and pasteurization, but may be considerably inferior to certified milk. It, however, is less expensive to produce and may be sold at a lower figure. This milk is usually sold raw, *i.e.,* without being pasteurized.

Certified milk is milk the cleanliness of which has been certified to by the local health board or certification committee of physicians. Such milk must have been produced from cows tested and found free from disease and produced under conditions of stable and milkers, such as to insure the presence of not to exceed 10,000 bacteria per cubic centimeter at the time of delivery to the consumer.

The production of certified milk involves identically the same factors as mentioned in the production of clean milk, with the exception that each point is carried to a greater degree; thus the cows must be a little cleaner, the stable atmosphere a little freer of dust, the milkers' hands cleansed before the milking of each cow, all pails and cans thoroughly sterilized and the milk cooled at once to 50 degrees or below.

In the past an immense amount of unnecessary expense has been incurred in the production of certified milk. Millionaires of good intentions have lavished their wealth upon cow stables and bottling outfits with the result that there was no profit in the industry when the interest on the money invested was taken into account. Often, too, the cooling and bottling machines were so elaborate as to be difficult of cleaning. This naturally resulted in the production of an article considerably inferior to that which could be produced by means of a simple and less expensive outfit. It is gratifying to note that there is now a tendency away from the unnecessary dairy refinements with a more tenacious clinging to the points essential in clean milk production. In Chapter XXVI are given the chief rules and regulations laid down for the production of certified milk.

Homogenized milk is milk rendered homogeneous, or uniform, throughout. Homogenization of milk involves not only the pulverization of the fat globules, as originally thought, but also the breaking up of the casein shreds as well. The process may, and usually does, also involve pasteurization, since milk may be more readily and rapidly homogenized at a comparatively high temperature. The homogenizer is a machine consisting essentially of three or more pumps which force the milk through a small aperture against a hard surface under a pressure of from two to five thousand pounds per square inch. In practice homogenization is now employed most largely by ice cream manufacturers and the pressure and temperature employed vary with the use to which the cream or milk is to be put. Unsalted butter and skim milk may easily, by the aid of this machine, be emulsified into a milk or cream of any desired fat percentage. Thus it may be employed in cream and ice cream making in the winter season when fresh cream is scarce and high priced.

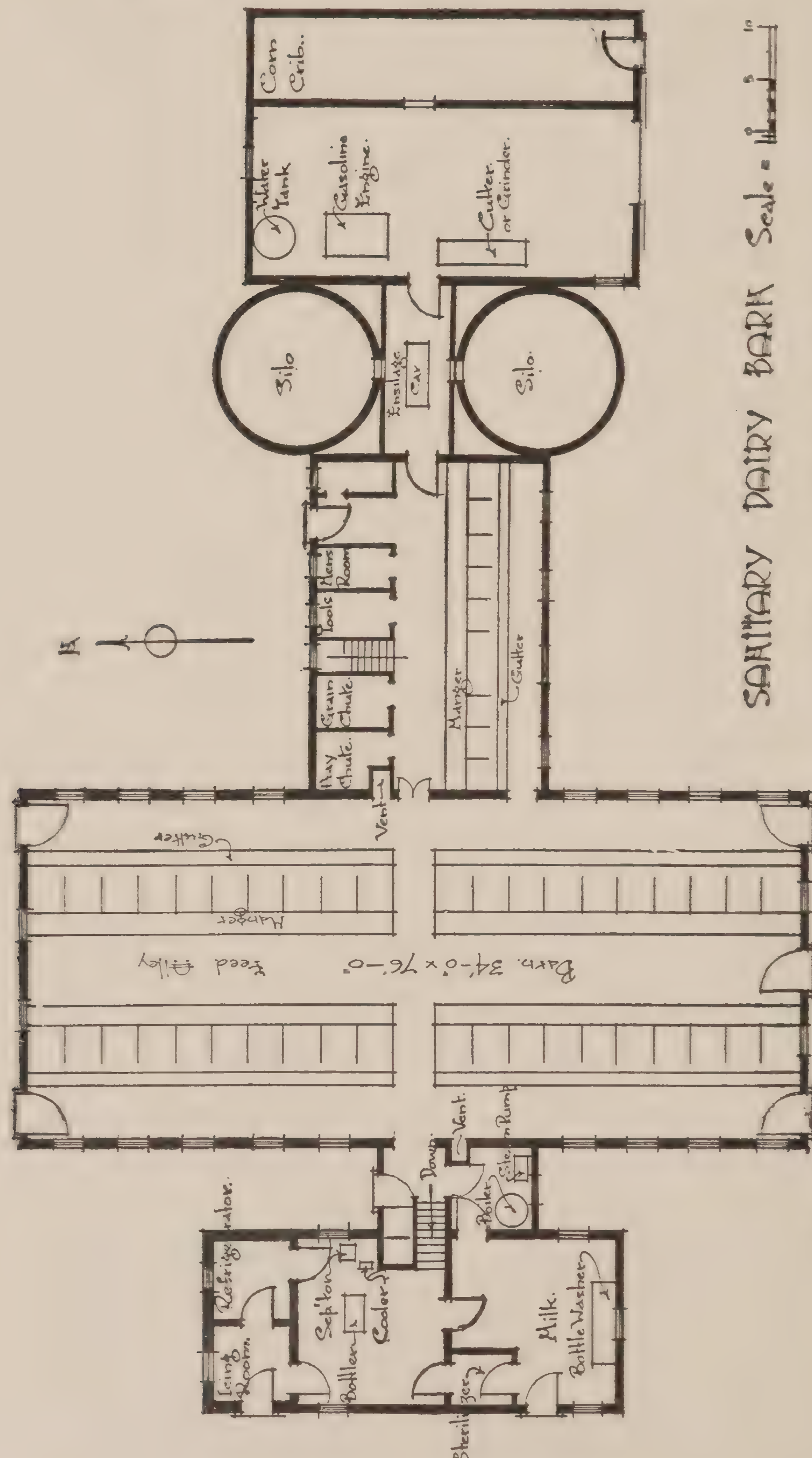

FIG. 127.—Plan of sanitary stable and milk house at "Hillcrest" Dairy, Greenwood, Mo.

Homogenized milk for infant feeding has been advocated for several years and though possessing a little merit, its value has been greatly over-estimated. The size of the fat globule, thought to be important, has been shown to be an exceedingly small factor compared with the percentage amount of fat in the milk fed and its proportion to other solids. It is exceedingly more important that the milk shall be medium to low in fat than that the globules of fat be small in size. Homogenized milk produces a fine flocculent curd, one which never clots into the hard rubbery mass characteristic of normal milk. This production of a friable curd is thought to be of more importance in the digestion of the milk by the infant than the small size of the fat globule. If, together with the breaking up of the fat and the casein in milk, it has also been thoroughly pasteurized and also kept low in fat percentage, then homogenized milk is of definite value in the feeding of delicate bottle-fed infants.

METHODS OF SELLING MILK

A milk rich in food solids is worth more per quart than that which is poor; likewise, milk which is clean is worth more than dirty milk. In winter, milk is generally less abundant and therefore higher in price. How to arrange sales from producer to distributer with three varying elements and yet not make the affair too complicated to be workable has long been a problem. Milk is now being purchased on no less than fourteen bases, ranging all the way from so much per "can," irrespective of fat and bacteria content, to a plan involving three sliding scales, one for cleanliness, one for fat content, and one for time of the year. All three are just reasons for modifying the price, yet they combine to make great complexity, which in turn makes for suspicion and dissatisfaction.

The best plan, theoretically at least, is that now being tried by the Borden Milk Company, New York City. For any given month the price is fixed, based on Grade B milk (see Chapter XXV) at say $1.75 per hundred for milk testing 3.5 per cent fat; then for every tenth of a per cent increase in fat

over 3.5, three cents extra are paid, and for every tenth below three cents are deducted, thus a 5.0 per cent milk would bring \$2.20 and a 3.0 per cent milk would be worth \$1.60. In addition five cents extra per hundred is paid for Grade A milk and a like amount subtracted if the milk falls into the Grade C class. Thus, 100 pounds of 5 per cent Grade A would be worth \$2.25, while 100 pounds of 3.0 per cent Grade C would bring only \$1.55. A different price standard for each month in the year may then be announced in advance with a table indicating just what any particular class and grade will be worth.

There is a strong tendency throughout the middle west to buy on the fat test solely, to buy, as it were, the fat in the form of milk.

The breeders of Jersey and Guernsey cattle will welcome any system that pays for quality.

QUESTIONS

1. What is meant by "loose" milk?
2. Why is bottled milk more likely to be good than loose milk in cities?
3. What is clarified milk?
4. What is standardized milk?
5. What is pasteurization? Explain the three systems.
6. What is "sanitary" milk?
7. What is certified milk? How is it produced?
8. What is homogenized milk?
9. Describe the method of selling milk in vogue in any city with which you are familiar.
10. Describe the Borden Milk Company's plan.

CHAPTER XXXIX

FOOD VALUE OF MILK

Any serious consideration of the use of milk as a food should take into account both the composition of the milk and the use to be made of it, for not only does milk vary greatly in composition but the work to be done by milk varies nearly if not quite as much.

Milk for Adults.—While milk rich in fat possesses more food value there might easily be conditions under which skim milk, or that from which a part of the fat has been removed, might be more valuable, that is, would do the individual consuming the milk more good.

Milk varies not only in its fat content, but in other solids as well, as will be noted from the table.

Composition of Milk.[1]

Fat Per cent	Protein, Casein and Albumen Per cent	Carbohydrates (sugar) Per cent	Total Starch Value Per cent
2.5	2.55	4.45	12.62
3.0	2.68	4.60	14.03
3.5	2.81	4.75	15.43
4.0	3.08	4.85	16.93
4.5	3.27	4.97	18.96
5.0	3.45	4.98	19.68
5.5	3.65	4.92	20.94
6.0	3.82	4.96	22.23
6.5	4.12	4.90	23.67
7.0	4.22	4.84	24.81

The solids, other than fat, in milk are chiefly casein and albumen, which make up the protein or muscle-building portion of the milk, and sugar, which can be used by the consumer only to furnish energy and heat and produce fat, and ash, which is the material from which bone is formed. The sugar of milk, like other sugars and starches, is known as carbohydrate. From

[1] Minnesota Bulletin 140.

the above table it is readily observed that as the fat increases in the milk the other solids increase likewise, though not in proportion. Sugar is the most constant of all the substances and fat the most variable. The last column in the table, indicated as "starch value," shows the number of pounds of starch or other similar pure carbohydrates which would be required to equal in total heating or energy value 100 pounds of milk of the grade indicated. Thus, we see that 14.03 pounds of starch would be required to equal 100 pounds of 3 per cent milk in food value, while 22.23 pounds of starch would be required as the equivalent of 100 pounds of 6 per cent milk. It will be observed further that milk naturally containing 7 per cent fat, which amount is not at all unusual with Jersey cows, possesses practically twice the food value of milk naturally containing only 2½ per cent fat, despite the fact that sugar, casein and albumen remain as more nearly constant qualities.

This question of relative food values of milks of varying fat grade is best shown by figure 128. In this it is readily seen that 100 pounds or a quart of natural milk testing 5.5 per cent fat contains nearly half again more food than one naturally yields at 3.25 per cent fat content.

From a study of this table and figure it might naturally be inferred that the milks which are naturally richer in fat possess more food value and are worth actually more money per quart. This is true under ordinary conditions. If the milk is consumed by adults or by children after they are eating ordinary foodstuffs, the more solids it contains the more valuable it will be, not in proportion to the fat content, but in proportion to the starch value figure. This table also clearly shows the unreasonableness on the part of some consumers for a rich milk at a poor milk price, for it must be remembered that cows do not create milk or anything else, they merely transform the feed materials which they eat from that of hay and grain into the milk solids. More cow feed is required to produce a quart of rich milk than a quart of poor milk.

Most foods are firm to the touch and are sold by the pound, while milk is watery and sold by the quart. The unit in the

case of milk is more than twice that of most other food substances. For these reasons it is so easy to think of milk as a beverage that few people realize or can appreciate when they are clearly told that milk actually carries more food substance per pound than most of the garden vegetables. See table of composition.

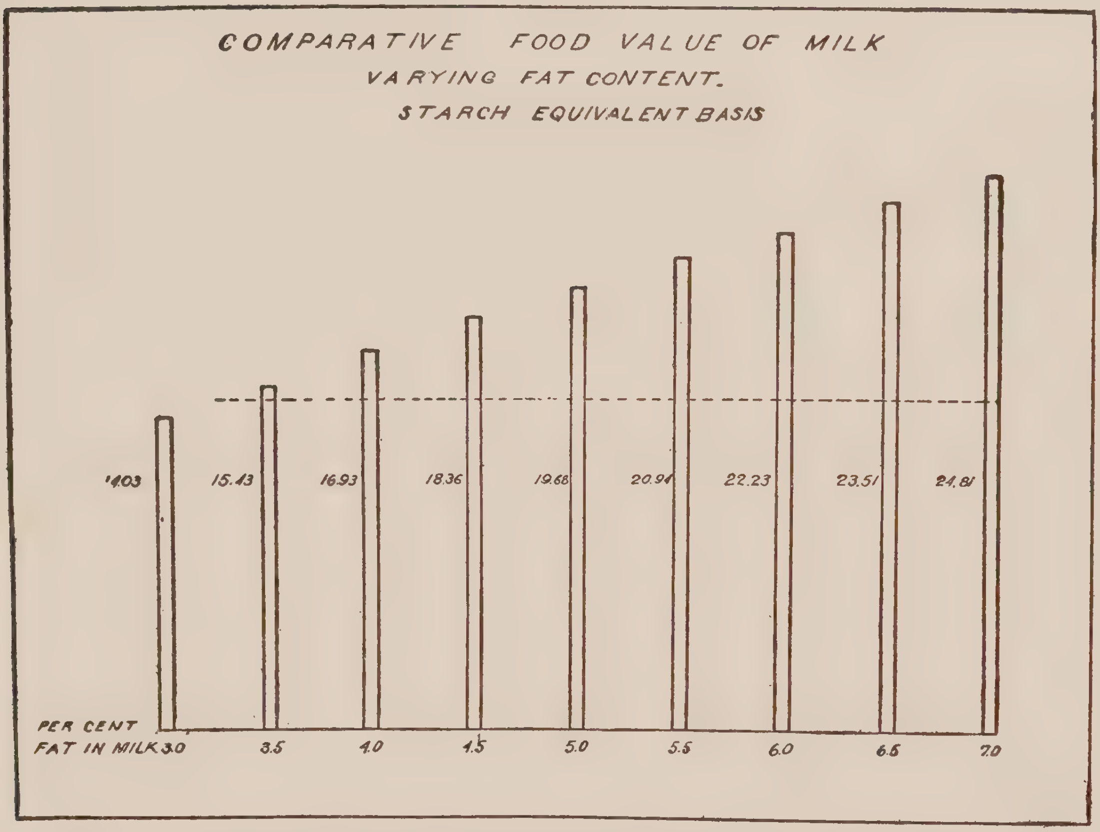

Fig. 128.—Total food value of milk of various grades. The height of the bars is proportional to the total food value of the milk and the distance from the base line to the dotted line represents the value of a standardized 3¼ per cent milk. Note that a normal 6 per cent milk contains nearly 50 per cent more food than the standard.

A strict comparison of qualities and values in milk, however, must take into account the fact that milk is an animal product and like meat and eggs, very easily and thoroughly digested, which is not the case with cereals and vegetables. Therefore, correct and fair comparison can be made only between milk and other animal feeds. Furthermore, the comparison should be between milk of a definite grade and meats or other such foods which carry enough fat to make their composition comparable; or, in other words, they should have approximately the same

ratio of nutrients. In a study of our common animal foods on this basis we find that the cost per pound of edible dry matter, actual food substance, varies tremendously with the composition of the food as well as with the price paid, as shown in the table.

Cost Per Pound Dry Matter, Milk vs. Other Foods

Kind of Food	Retail Price	Cost per pound Digestible Dry Matter
Fat porter house steak	30 cents per pound	$ .80
Round steak	20 cents per pound	.64
Hamburg steak	20 cents per pound	.60
Eggs (1 dozen = 1½ pounds)...	30 cents per dozen	.85
Skim milk	4 cents per quart	.24
Oysters (solids)	40 cents per quart	2.00
Plain milk, 3.25 per cent fat.....	7 cents per quart	.28
Plain milk, 3.25 per cent fat.....	8 cents per quart	.32
Ham	25 cents per pound	.65
Certified milk, 4.0 per cent fat..	15 cents per quart	.52
Sanitary milk, 3.25 per cent fat.	12 cents per quart	.48
Cream, 20 per cent fat..........	40 cents per quart	.75
Bacon	25 cents per pound	.35
Ice cream, 12 per cent fat	30 cents per quart	.72

A study of the table reveals the surprising fact that even though 4 cents per quart were charged for skim milk it furnishes edible dry matter for approximately 24 cents per pound, as against 80 cents in the case of porter house steak, 80 cents to $1 per pound in the case of eggs, and $2 per pound in the case of oysters. It should be remembered too that these foods are similar in their nutrients and possess chemical character making them essentially equivalent in their bone, muscle and fat producing qualities.

Following into the second division, where ordinary market milk is compared with smoked ham, it is observed that even certified milk at 15 cents per quart is a cheaper food than is smoked ham at 25 cents per pound. Ham, it will be remembered, is covered over much of its surface by rind and possesses a bone, neither of which is edible, and that the edible flesh itself is prac-

tically half water. Water is the great "joker" in the whole food study. Good sanitary milk of 4.0 per cent fat at 12 cents per quart (6 cents per pound) furnishes food for one-third to one-half the price per pound that is regularly paid for meat foods.

Certified milk costs too much for most purposes, however, because of the excessive amount of labor required in its production. Those having healthy young children to feed may find that sanitary milk selling at ten to twelve cents per quart is equally as valuable and considerably less expensive. Ordinarily, plain market milk at 7 cents per quart furnishes food, even for the adult, at practically one-half the cost per pound of smoked ham.

This same question may easily be expressed in other terms, as shown in the following table:

Value of Milk When Compared with Other Foods

Kind of Food	Retail Selling Price	In Comparison Milk is worth per Qt.
Porter house steak	30 cents per pound	20 cents
Round steak	20 cents per pound	16 cents
Ham	25 cents per pound	16 cents
Eggs	30 cents per dozen	21 cents
Oysters	40 cents per quart	50 cents

All of the above refers to the use of milk by those who consume other foods and take milk as supplementary or as an adjunct to the regular meal.

Milk for Infants.—Infants, while too young to readily digest starch or endure cellulose, must of necessity live largely or wholly upon milk. The substance of the bones and muscle grown by the child during this period must come from the milk used. It has now been conclusively shown that the chemical composition of the milk consumed determines the composition of the flesh produced from it. The ratio or proportion of muscle to fat in the experimental animal bore a constant relation to the ratio of the protein to fat-producing elements in the milk con-

sumed. The proportion of the various food substances of milk of varying fat grade is well shown in the accompanying table.

Percentage Composition of Water-free Substance in Milk of Varying Fat Content [2]

Grade of Milk Per cent	Butter Fat Per cent	Protein Per cent	Carbohydrates Per cent	Ash Per cent
3.0 fat	27.27	24.36	41.83	6.54
3.5 fat	29.76	23.89	40.40	5.95
4.0 fat	31.70	24.40	38.45	5.46
4.5 fat	33.41	24.28	36.89	5.42
5.0 fat	35.28	24.35	35.22	5.15
5.5 fat	37.16	24.66	33.25	4.93
6.0 fat	38.78	24.69	31.75	4.78
6.5 fat	39.95	25.32	30.12	4.61
7.0 fat	41.62	25.09	28.78	4.51

The relative amounts of the chief ingredients of milk are shown in Fig. 129, which is drawn to scale from this table. This emphasizes the predominance of fat over other solids in such food.

The especial attention of the reader is called to the fact that whereas 6.54 per cent of the 3 per cent milk is ash available for building of bone in the child, only about two-thirds of that quantity of ash is present in the rich milk. It will be noted that whereas only 27.27 per cent of the total milk solids are fat in the case of 3 per cent milk, 38.78 per cent are fat in the case of 6 per cent milk, and 41.62 per cent in the case of 7 per cent milk. Whenever the milk fed to the child brings fat and sugar to the child's system, in quantities greater than needed for normal growth, in conjunction with the muscle-building protein and bone-building ash, that child becomes over-fat, weak, subject to eczema, rickets, and other infantile scourges. This may be shown to best advantage by using figures obtained in a series of experiments carried on at the Vermont Station, reported in Bulletin 195 (see table, top of next page).

The nation-wide habit of allowing milk to stand until the cream has largely risen and then using the "top-milk" with water and sugar added for the feeding of infants is exceedingly dangerous and has unquestionably been the foundation cause

[2] Minnesota Bulletin 140.

Effect of Composition of Food Upon the Character of Body Gain.

Kind of Food.	Per cent Fat.	Nutritive Ratio=1:	Ratio of Muscle to Fat=1:	Condition of the Animals.	Number in Average.
Skim milk......	.04	1.28	.86	Rough Hard Active	16
Medium milk...	2.67	2.90	1.61	Smooth Firm Active	27
Rich milk......	4.72	4.27	2.52	Soft Sluggish Tender	15

for weakness in the after-life of a great many American infants.

Stockmen have known for a great many years that the milk of a Holstein cow, testing little better than 3 per cent fat, will produce a stronger, healthier calf than will the milk

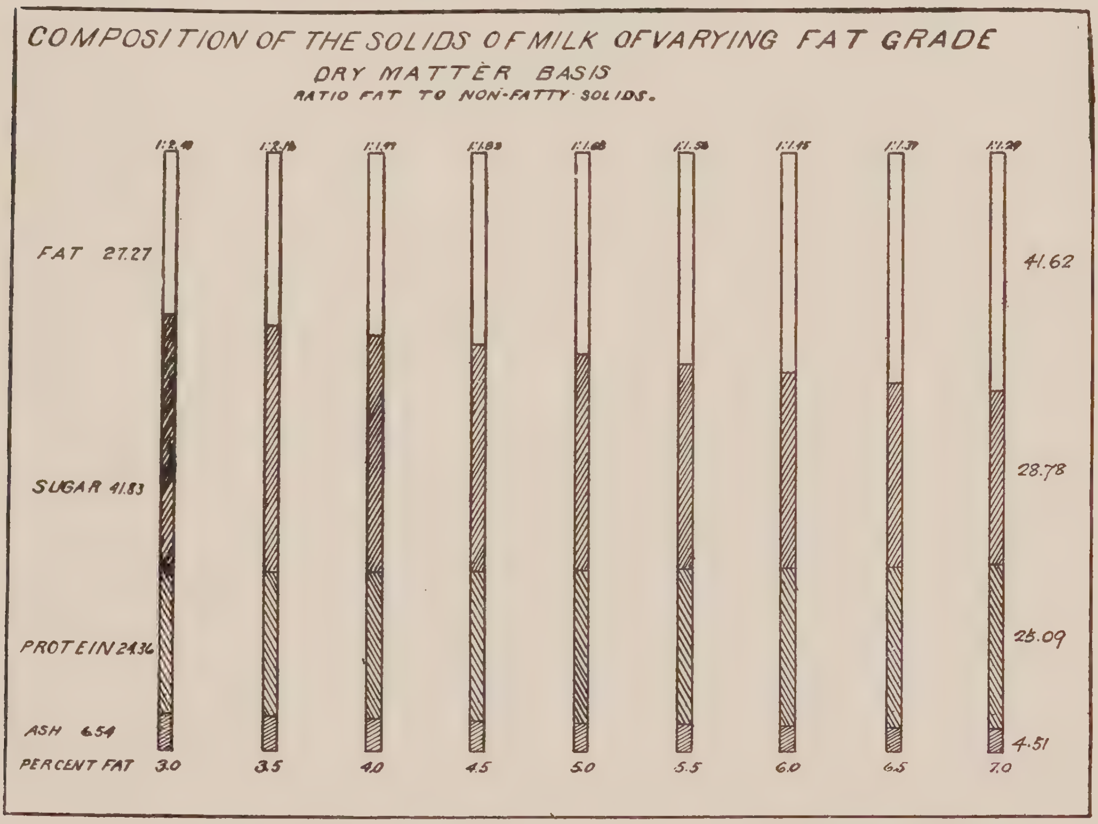

FIG. 129.—Emphasizing the change of the proportion of fat to non-fatty solids in the solid matter of milk of varying fat grades; also that 2.43 pounds of low-priced solids accompanied each one pound of fat in the 3.0 per cent milk, whereas, only 1.29 pounds of cheap solids were required to be produced to accompany each pound of fat with a 7 per cent milk.

of a Jersey or Guernsey cow, which milk will test from 5 to 6 per cent fat (Fig. 129). The true value of the milk that is to nourish two-thirds or 1,500,000 of our infant population depends

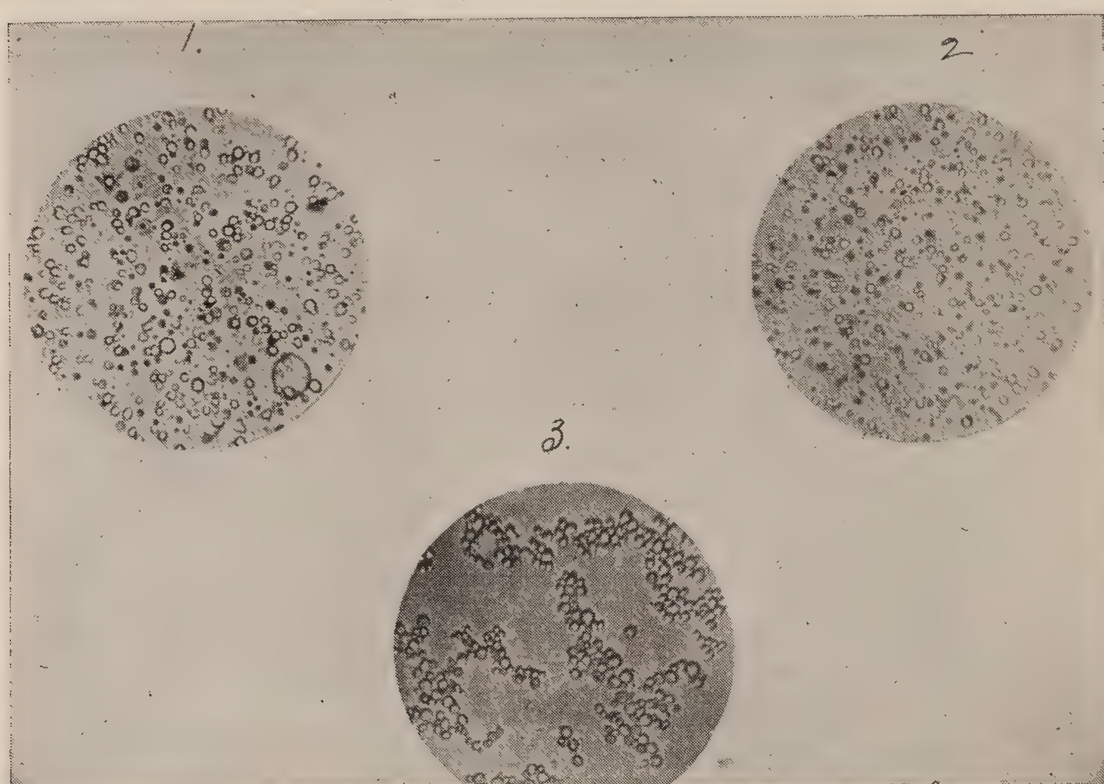

Fig. 130.—Photomicrographs of fat globules in milk. 1. Grade Jersey. 2. Grade Holstein. 3. Human. (Courtesy of the Vermont Station.)

upon its chemical composition quite as truly, if not quite so quickly, as upon the physical condition of the cow or the cleanness of the milk (Fig. 130).

QUESTIONS

1. What is meant by the "starch value" of milk?
2. How much do various natural milks vary in total food value?
3. What milk is most valuable to the adult?
4. How does the cost per pound of edible solid matter in milk compare with meat, eggs and oysters?
5. In comparison what is milk worth per quart?
6. What milk is best suited to the needs of a growing infant and young child?
7. How did medium and rich milks compare in effect on infant pigs in a Vermont test?
8. What is the exprrience of stockmen with regard to grade of milk best suited to calf feeding?

CHAPTER XL

GOVERNMENT STANDARDS OF PURITY FOR MILK AND ITS PRODUCTS

A. MILKS

1. **Milk** is the fresh, clean, lacteal secretion obtained by the complete milking of one or more healthy cows, properly fed and kept, excluding that obtained within fifteen days before and ten days after calving, and contains not less than eight and one-half (8.5) per cent of solids not fat, and not less than three and one-quarter (3.25) per cent of milk fat.

2. **Blended milk** is milk modified in its composition so as to have a definite and stated percentage of one or more of its constituents.

3. **Skim milk** is milk from which a part or all of the cream has been removed and contains not less than nine and one-quarter (9.25) per cent of milk solids.

4. **Pasteurized milk** is milk that has been heated below boiling but sufficiently to kill most of the active organisms present and immediately cooled to 50 degrees F. or lower.

5. **Sterilized milk** is milk that has been heated at the temperature of boiling water or higher for a length of time sufficient to kill all organisms present.

6. **Condensed milk, evaporated milk,** is milk from which a considerable portion of water has been evaporated and contains not less than twenty-eight (28) per cent of milk solids, of which not less than twenty-seven and five-tenths (27.5) per cent is fat. Condensed milks must, then, contain 7.7 per cent of fat.

7. **Sweetened condensed milk** is milk from which a considerable portion of water has been evaporated and to which sugar (sucrose) has been added, and contains not less than twenty-eight (28) per cent of milk solids, of which not less than twenty-seven and five-tenths (27.5) per cent is milk fat.

8. **Condensed skim milk** is skim milk from which a considerable portion of water has been evaporated.

9. **Buttermilk** is the product that remains when butter is removed from milk or cream in the process of churning.

10. **Goat's milk, ewe's milk, etc.,** are the fresh, clean, lacteal secretions, free from colostrum, obtained by the complete milking of healthy animals other than cows, properly fed and kept, and conform in name to the species of animals from which they are obtained.

B. CREAM

1. **Cream** is that portion of milk, rich in milk fat, which rises to the surface of milk on standing, or is separated from it by centrifugal force, is fresh and clean and contains not less than eighteen (18) per cent of milk fat.

2. **Evaporated cream, clotted cream,** is cream from which a considerable portion of water has been evaporated.

C. MILK FAT OR BUTTER FAT

1. **Milk fat, butter fat,** is the fat of milk and has the Reichert-Meissel number not less than twenty-four (24) and a specific gravity of not less than 0.905 $\left(\frac{40°C.}{40°C.}\right)$ (Both fat and standard at this temperature.)

D. BUTTER

1. **Butter** is the clean, non-rancid product made by gathering in any manner the fat of fresh or ripened milk or cream into a mass, which also contains a small portion of the other milk constituents, with or without salt, and contains not less than eighty-two and five-tenths (82.5) per cent of milk fat. By acts of Congress approved August 2, 1886, and May 9, 1902, butter may also contain added coloring matter.

2. **Renovated butter, process butter,** is the product made by melting butter and reworking, without the addition or use of chemicals or any substances except milk, cream, or salt, and contains not more than sixteen (16) per cent of water and at least eighty-two and five-tenths (82.5) per cent of milk fat.

E. CHEESE

1. **Cheese** is the sound, solid, and ripened product made from milk or cream by coagulating the casein thereof with rennet or lactic acid, with or without the addition of ripening ferments and seasoning, and contains, in the water-free substance, not less than fifty (50) per cent of milk fat. By act of Congress, approved June 6, 1896, cheese may also contain added coloring matter.

2. **Skim milk cheese** is the sound, solid, and ripened product, made from skim milk by coagulating the casein thereof with rennet or lactic acid, with or without the addition of ripening ferments and seasoning.

3. **Goat's milk cheese, ewe's milk cheese, etc.,** are the sound, ripened products made from the milks of the animals specified, by coagulating the casein thereof with rennet or lactic acid, with or without the addition of ripening ferments and seasoning.

F. ICE CREAM

1. **Ice cream** is a frozen product made from cream and sugar, with or without a natural flavoring, and contains not less than fourteen (14) per cent of milk fat.

2. **Fruit ice cream** is a frozen product made from cream, sugar, and sound, clean, mature fruits, and contains not less than twelve (12) per cent of milk fat.

3. **Nut ice cream** is a frozen product made from cream, sugar, and sound, non-rancid nuts, and contains not less than twelve (12) per cent of milk fat.

G. MISCELLANEOUS MILK PRODUCTS

1. **Whey** is the product remaining after the removal of fat and casein from milk in the process of cheese-making.

2. **Kumiss** is the product made by the alcoholic fermentation of mare's or cow's milk.

Composition of Milk and Its Products

	No of Analyses	Water Per ct.	Fat Per ct.	Casein and Albumen Per ct.	Milk Sugar Per ct.	Ash Per ct.	Authority
Cow's milk	793	87.17	3.69	3.55	4.88	.71	König
Cow's milk	...	87.75	3.40	3.50	4.60	.75	Fleishmann
Cow's milk	5,552	87.10	3.90	3.20	5.10	.70	Van Slyke
Cow's milk	200,000	87.10	3.90	3.40	4.85	.75	Richmond
Colostrum milk..	42	74.57	3.59	17.64	2.67	1.56	König
Cream	43	68.82	22.66	3.76	4.23	.53	König
Skim milk (gravity)	56	90.43	.87	3.26	4.74	.70	König
Skim milk (gravity)	354	90.52	.32	....	....	...	Holland
Skim milk (centrifugal) ..	..	90.30	.10	3.55	5.25	.80	Van Slyke
Buttermilk	57	90.12	1.09	4.03	4.04	.72	König
Buttermilk	31	91.67	.27	....	....	...	Holland
Whey	46	93.38	.32	.86	4.79	.65	Konig
Whey	..	93.12	.27	.81	5.80	...	Van Slyke
Condensed milk (no sugar added)..	36	58.99	12.42	11.92	14.49	2.18	König
Condensed milk, (sugar added).	64	25.61	10.35	11.79	50.06	2.19	König
Butter, salted....	1,676	11.95	84.27	1.26	.....	2.58	Woll
Butter, sweet cream...	10	12.93	84.53	.61	.68	1.25	König
Butter, sour cream....	11	13.08	84.26	.81	.66	1.19	König
Butter, unsalted.	242	13.07	85.24	1.57	...	.12	Woll
Butter, World's Fair, 1893.......	350	11.57	84.70	.95	...	2.78	Farrington
Cheese, cream......	127	36.33	40.71	18.84	1.02	3.10	König
Cheese, full cream ..	143	38.00	30.25	25.35	1.43	4.97	König
Cheese, cheddar, green	...	36.84	33.83	23.72	5.61	....	Van Slyke
Cheese, cheddar, cured	27	34.38	32.71	26.38	2.95	3.58	Drew
Cheese, World's Fair, Mammoth, 1893	1	32.06	34.43	28.00	5.51	....	Shutt
Cheese, half-skim...	21	39.79	23.92	29.67	1.79	4.73	König
Cheese, skim.......	41	46.00	11.65	34.06	3.42	4.87	König
Cheese, centrifugal skim..	..	50.5	1.2	43.1	....	5.2	Storch

STANDARDS FOR BABCOCK GLASSWARE

(Adopted by the Association of Official Agricultural Chemists of North America.)

Sec. 1. The unit of graduation for all Babcock glassware shall be the true cubic centimeter (0.998877 gram of water at 4 degrees C.).

(a) With bottles, the capacity of each per cent on the scale shall be two-tenths (0.20) cubic centimeter.

(b) With pipettes and acid measures the delivery shall be the intent of the graduation and the graduation shall be read with the bottom of the meniscus in line with the mark.

Sec. 2. The official method for testing bottles shall be calibration with mercury (13.5471 grams of clean, dry mercury at 20 degrees C., carefully weighed on analytical balances, to be equal to 5 per cent on the Babcock scale), the bottles being previously filled to zero with mercury.

Sec. 3. Optional Methods.—The mercury and cork, alcohol and burette, and alcohol and brass plunger methods may be employed for the rapid testing of Babcock bottles, but the accuracy of all questionable bottles shall be determined by the official method.

Sec. 4. The official method for testing pipettes and acid measures shall be calibration by measuring in a burette the quantity of water (at 20 degrees C.) delivered.

Sec. 5. The Limits of Error.—(a) For Babcock bottles shall be the smallest graduation on the scale, but in no case shall it exceed five-tenths (0.50) per cent, or for skim milk bottles one-hundredth (0.01) per cent.

(b) For full-quantity pipettes, it shall not exceed one-tenth (0.10) cubic centimeter, and for fractional pipettes, five-hundredths (0.05) cubic centimeter.

(c) For acid measures it shall not exceed two-tenths (0.20) cubic centimeter.

Chemical Standards for Milk and Cream in Sixty American Cities.

City	Per cent of milk fat	Per cent of other solids	Per cent solids for skim-milk	Per cent fat for cream
Allentown, Pa.	3.25	8.5	9	..
Atlantic City, N. J.	3	8.5	...	16
Augusta, Ga.	3.5	9	9	18
Baltimore, Md.	3.5	9	...	18
Birmingham, Ala.	3.5	9	9	18
Boston, Mass.	3.35	8.8	9.3	15
Battle Creek, Mich.	3	9.5	...	13
Beaumont, Tex.	3.25	8.5	...	..
Butte, Mont.	3.3	8.7	8	20
Charlotte, N. C.	3.25	8.5	8.75	18
Chicago, Ill.	3	9	8.5	15
Cincinnati, Ohio	3	9	...	18
Cleveland, Ohio	3	8	9	18
Columbia, S. C.	3	9	9.3	16
Columbus, Ohio	3	9	9.3	..
Denver, Colo	3	9	...	16
Detroit, Mich.	3	9	9.3	18
Elyria, Ohio	3	9	9.3	16
Fall River, Mass.	3.25	8	...	16
Flint, Mich.	3	...	...	20
Grand Rapids, Mich.	3	9.5	...	18
Great Falls, Mont.	3.25	8.5	9.5	18
Houston, Tex.	3.25	8.75	...	18
Indianapolis, Ind.	3.25	8.5	9.25	18
Jacksonville, Fla.	3	9	...	..
Jersey City, N. J.	3	8.5	...	18
Kansas City, Mo.	3.25	8.75	8.5	18
Little Rock, Ark.	3.5	12.5	9	18
Long Beach, Cal.	3.5	12.5	8.8	20
Los Angeles, Cal.	3.5	9	8.8	20
Memphis, Tenn.	3.5	8.5	9.25	20
Minneapolis, Minn.	3.5	8.5	8.5	20
New Orleans, La.	3.5	8.5	8	..
Newark, N. J.	3	8.5	8.75	16
New Haven, Conn.	3.5	8	...	..
New York, N. Y.	3	8.5	...	18
North Yakima, Wash.	3.5	8.5	9.3	18
Oakland, Cal.	3.5	8.5	...	..
Omaha, Neb.	3.2	8.5	...	18
Philadelphia, Pa.	3.25	8.75	8.5	18
Paterson, N. J.	3	9	...	..
Portland, Ore.	3.2	8.5	...	20
Providence, R. I.	2.5	9.5	...	..
Rochester, N. Y.	3	9	...	..
Saginaw, Mich.	3	8.5	8.75	18
St. Joseph, Mo.	3.5	8.5	9.25	18
St. Louis, Mo.	3	9	9.25	15
St. Paul, Minn.	3.5	9.5	...	20
Salt Lake City, Utah	3.2	8.8	...	18
San Antonio, Tex.	3.5	8.5	9.25	..
San Francisco, Cal.	3.4	8.6	...	18
Seattle, Wash.	3.4	...	9.3	18
Spokane, Wash.	3.5	8.5	...	20
Syracuse, N. Y.	3	8.5	9.3	18
Tacoma, Wash.	3.5	8.5	9.3	18
Toledo, Ohio.	3	9	...	18
Topeka, Kansas.	3.5	8.5	9.25	18
Washington, D. C.	3.5	9	...	20
Winona, Minn.	3.5	9.5	...	20

Note the inconsistency in relationship between the per cent fat and the per cent of solids not fat, as expressed in the various ordinance requirements. See table on page 387.

APPENDIX

TABLE III—FEEDING STUFFS

Giving Pounds of Dry Matter and Nutrients Contained in a Given Number of Pounds of Feed Stuff.

Cured Roughage

Fodder Corn (Drilled)					Corn Stover				
Lbs.	Dry Matter	Digestible Pro.	Digestible C-H.	Digestible Fat	Lbs.	Dry Matter	Digestible Pro.	Digestible C-H.	Digestible Fat
1	.76	.037	.41	.015	1	.59	.014	.31	.007
2	1.52	.074	.83	.029	2	1.19	.028	.62	.014
3	2.28	.111	1.24	.044	3	1.78	.042	.94	.021
4	3.04	.148	1.66	.058	4	2.38	.056	1.25	.028
5	3.80	.185	2.07	.073	5	2.97	.070	1.56	.035
6	4.56	.222	2.48	.088	6	3.57	.084	1.87	.042
7	5.32	.259	2.90	.102	7	4.16	.098	2.18	.049
8	6.08	.296	3.31	.117	8	4.76	.112	2.50	.056
9	6.84	.333	3.73	.131	9	5.35	.126	2.81	.063
10	7.60	.370	4.14	.146	10	5 98	.140	3.12	.070

Sorghum Fodder					Millet				
1	.50	.024	.32	.016	1	.86	.050	.47	.011
2	1.01	.048	.64	.032	2	1.72	.100	.94	.022
3	1.51	.072	.96	.048	3	2.58	.150	1.41	.033
4	2.01	.096	1.28	.064	4	3.44	.200	1.88	.044
5	2.51	.120	1.60	.080	5	4.30	.250	2.34	.055
6	3.02	.144	1.93	.096	6	5.16	.300	2.81	.066
7	3.52	.168	2.25	.112	7	6.02	.350	3.28	.077
8	4.02	.192	2.57	.128	8	6.88	.400	3.75	.088
9	4.53	.216	2.89	.144	9	7.74	.450	4.22	.099
10	5.03	.240	3.21	.160	10	8.60	.500	4.69	.110

Timothy					Red Top				
1	.87	.028	.43	.014	1	.91	.048	.47	.010
2	1.74	.056	.87	.028	2	1.82	.096	.94	.020
3	2.60	.084	1.30	.042	3	2.73	.144	1.41	.030
4	3.47	.112	1.74	.056	4	3.64	.192	1.88	.040
5	4.34	.140	2.17	.070	5	4.55	.240	2.34	.050
6	5.21	.168	2.60	.084	6	5.47	.288	2.81	.060
7	6.08	.196	3.04	.098	7	6.38	.336	3.28	.070
8	6.94	.224	3.47	.112	8	7.29	.384	3.75	.080
9	7.81	.252	3.91	.126	9	8.20	.432	4.22	.090
10	8.68	.280	4.34	.140	10	9.11	.480	4.69	.100

Prairie (Upland)					Prairie (Mixed)				
1	.87	.03	.42	.014	1	.84	.029	.41	.012
2	1.75	.06	.84	.028	2	1.62	.058	.83	.024
3	2.62	.09	1.25	.042	3	2.52	.087	1.24	.036
4	3.50	.12	1.67	.056	4	3.36	.116	1.66	.048
5	4.37	.15	2.09	.070	5	4.20	.145	2.07	.060
6	5.25	.18	2.51	.084	6	5.05	.174	2.49	.072
7	6.12	.21	2.93	.098	7	5.89	.203	2.90	.084
8	7.00	.24	3.34	.112	8	6.73	.232	3.32	.096
9	7.87	.27	3.76	.126	9	7.57	.261	3.73	.108
10	8.75	.30	4.18	.140	10	8.41	.290	4.15	.120

TABLE III—Feeding Stuffs—*Continued*

Cured Roughage—*Continued*									
Prairie (Swale)					Barley				
Lbs.	Dry Matter	Digestible			Lbs.	Dry Matter	Digestible		
		Pro.	C-H.	Fat			Pro.	C-H.	Fat
1	.86	.026	.42	.011	1	.85	.057	.44	.01
2	1.73	.052	.84	.022	2	1.70	.114	.87	.02
3	2.59	.078	1.26	.033	3	2.55	.171	1.31	.03
4	3.45	.104	1.68	.044	4	3.40	.228	1.74	.04
5	4.31	.130	2.09	.055	5	4.25	.285	2.18	.05
6	5.18	.156	2.51	.066	6	5.10	.342	2.62	.06
7	6.04	.182	2.93	.077	7	5.95	.399	3.05	.07
8	6.90	.208	3.35	.088	8	6.80	.456	3.49	.08
9	7.77	.234	3.77	.099	9	7.65	.513	3.92	.09
10	8.63	.260	4.19	.110	10	8.50	.570	4.36	.10
	Oat					Pea			
1	.86	.047	.37	.017	1	.90	.080	.41	.017
2	1.72	.094	.73	.034	2	1.80	.160	.82	.034
3	2.58	.141	1.10	.051	3	2.71	.240	1.23	.051
4	3.44	.188	1.47	.068	4	3.61	.320	1.64	.068
5	4.30	.235	1.83	.085	5	4.51	.400	2.05	.085
6	5.16	.282	2.20	.102	6	5.41	.480	2.47	.102
7	6.02	.329	2.57	.119	7	6.31	.560	2.88	.119
8	6.88	.376	2.94	.136	8	7.22	.640	3.29	.136
9	7.74	.423	3.30	.153	9	8.12	.720	3.70	.153
10	8.60	.470	3.67	.170	10	9.02	.800	4.11	.170
	Cow Pea					Soy Bean			
1	.89	.058	.39	.013	1	.88	.106	.41	.012
2	1.79	.116	.78	.026	2	1.76	.212	.82	024
3	2.68	.174	1.80	.039	3	2.65	.318	1.23	.036
4	3.58	.232	1.57	.052	4	3.53	.424	1.64	.048
5	4.47	.290	1.96	.065	5	4.41	.530	2.04	.060
6	5.37	.348	2.36	.078	6	5.29	.636	2.45	.072
7	6.26	.406	2.75	.091	7	6.17	.742	2.86	.084
8	7.16	.464	3.14	.104	8	7.06	.848	3.27	.096
9	8.05	.522	3.54	.117	9	7.94	.954	3.68	.108
10	8.95	.580	3.93	.130	10	8.82	1.060	4.09	.120
	White Clover					Red Clover			
1	.90	.115	.42	.015	1	.85	.071	.38	.018
2	1.81	.230	.84	.030	2	1.69	.142	.76	.036
3	2.71	.345	1.27	.045	3	2.54	.213	1.13	.054
4	3.61	.460	1.69	.060	4	3.39	.284	1.51	.072
5	4.51	.575	2.11	.075	5	4.23	.355	1.89	.090
6	5.42	.690	2.53	.090	6	5.08	.426	2.27	.108
7	6.32	.805	2.95	.105	7	5.93	.497	2.65	.128
8	7.22	.920	3.38	.120	8	6.78	.568	3.02	.144
9	8.13	1.035	3.80	.135	9	7.62	.639	3.40	.162
10	9.03	1.150	4.22	.150	10	8.47	.710	3.78	.180

TABLE III—Feeding Stuffs—*Continued*

Cured Roughage—*Continued*									
Alsike Clover					Alfalfa				
Lbs.	Dry Matter	Digestible			Lbs.	Dry Matter	Digestible		
		Pro.	C-H.	Fat			Pro.	C-H.	Fat
1	.90	.084	.42	.015	1	.94	.117	.41	.01
2	1.81	.168	.85	.030	2	1.87	.234	.82	.02
3	2.71	.252	1.27	.045	3	2.81	.351	1.23	.03
4	3.61	.336	1.70	.060	4	3.74	.467	1.64	.04
5	4.51	.420	2.12	.075	5	4.68	.585	2.04	.05
6	5.42	.504	2.55	.090	6	5.62	.702	2.45	.06
7	6.32	.588	2.97	.105	7	6.55	.819	2.86	.07
8	7.22	.672	3.40	.120	8	7.49	.936	3.27	.08
9	8.13	.756	3.82	.135	9	8.42	1.053	3.68	.09
10	9.03	.840	4.25	.150	10	9.36	1.170	4.09	.10
	Wheat Straw					Oat Straw			
1	.90	.008	.35	.004	1	.91	.013	.39	.008
2	1.81	.016	.70	.008	2	1.82	.026	.79	.016
3	2.71	.024	1.06	.012	3	2.72	.039	1.18	.024
4	3.62	.032	1.41	.016	4	3.63	.052	1.58	.032
5	4.52	.040	1.76	.020	5	4.54	.065	1.97	.040
6	5.42	.048	2.11	.024	6	5.45	.078	2.37	.048
7	6.33	.056	2.46	.028	7	6.36	.091	2.76	.056
8	7.23	.064	2.82	.032	8	7.26	.104	3.16	.064
9	8.14	.072	3.17	.036	9	8.17	.117	3.55	.072
10	9.04	.080	3.52	.040	10	9.08	.130	3.95	.080
	Barley Straw					Kaffir Forage			
1	.86	.009	.40	.006	1	.48	.009	.26	.011
2	1.72	.018	.80	.012	2	.96	.019	.52	.022
3	2.57	.027	1.20	.018	3	1.44	.028	.78	.033
4	3.43	.036	1.60	.024	4	1.92	.038	1.04	.044
5	4.29	.045	2.00	.030	5	2.39	.047	1.29	.055
6	5.15	.054	2.41	.036	6	2.87	.057	1.55	.066
7	6.01	.063	2.81	.042	7	3.35	.066	1.81	.077
8	6.86	.072	3.21	.048	8	3.83	.076	2.07	.088
9	7.72	.081	3.61	.054	9	4.31	.085	2.33	.099
10	8.58	.090	4.01	.060	10	4.79	.095	2.59	.110
	Oat and Pea Hay					Oat and Vetch Hay			
1	.89	.076	.41	.015	1	.85	.083	.36	.013
2	1.79	.152	.83	.030	2	1.70	.166	.72	.026
3	2.68	.228	1.24	.045	3	2.55	.249	1.07	.039
4	3.58	.304	1.66	.060	4	3.40	.332	1.43	.052
5	4.47	.380	2.07	.075	5	4.25	.415	1.79	.065
6	5.37	.456	2.49	.090	6	5.10	.498	2.15	.078
7	6.26	.532	2.90	.105	7	5.95	.581	2.51	.091
8	7.16	.608	3.32	.120	8	6.80	.664	2.86	.104
9	8.05	.684	3.73	.135	9	7.65	.747	3.22	.117
10	8.95	760	4.15	.150	10	8.50	.830	3.58	.130

TABLE III—Feeding Stuffs—*Continued*

Silage

Lbs.	Dry Matter	Digestible Pro.	Digestible C-H.	Digestible Fat
	Corn Silage			
1	.26	.012	.14	.007
2	.53	.025	.28	.014
3	.79	.037	.43	.021
4	1.06	.050	.57	.028
5	1.32	.062	.71	.035
6	1.58	.075	.85	.042
7	1.85	.087	.99	.049
8	2.11	.100	1.14	.056
9	2.38	.112	1.28	.063
10	2.64	.125	1.42	.070
	Clover Silage			
1	.28	.020	.13	.010
2	.56	.040	.27	.020
3	.84	.060	.40	.030
4	1.12	.080	.54	.040
5	1.40	.100	.67	.050
6	1.68	.120	.81	.060
7	1.96	.140	.94	.070
8	2.24	.160	1.08	.080
9	2.52	.180	1.21	.090
10	2.80	.200	1.35	.100
	Cow Pea Silage			
1	.21	.015	.09	.009
2	.41	.030	.17	.018
3	.62	.045	.26	.027
4	.83	.060	.34	.036
5	1.03	.075	.43	.045
6	1.24	.090	.52	.054
7	1.45	.105	.60	.063
8	1.66	.120	.69	.072
9	1.86	.135	.77	.081
10	2.07	.150	.86	.090
	Pea Cannery Refuse			
1	.23	.021	.13	.008
2	.46	.042	.26	.016
3	.70	.063	.39	.024
4	.93	.084	.52	.032
5	1.16	.105	.65	.040
6	1.39	.126	.79	.048
7	1.62	.147	.92	.056
8	1.86	.168	1.05	.064
9	2.09	.189	1.18	.072
10	2.32	.210	1.31	.080

Lbs.	Dry Matter	Digestible Pro.	Digestible C-H.	Digestible Fat
	Sorghum Silage			
1	.24	.004	.13	.002
2	.48	.008	.27	.004
3	.72	.012	.40	.006
4	.96	.016	.54	.008
5	1.19	.020	.67	.010
6	1.43	.024	.81	.012
7	1.67	.028	.94	.014
8	1.91	.032	1.08	.016
9	2.15	.036	1.21	.018
10	2.39	.040	1.35	.020
	Alfalfa Silage			
1	.27	.030	.08	.019
2	.55	.060	.17	.038
3	.82	.090	.25	.057
4	1.10	.120	.34	.076
5	1.37	.150	.42	.095
6	1.65	.180	.51	.114
7	1.92	.210	.59	.133
8	2.20	.240	.68	.152
9	2.47	.270	.76	.171
10	2.75	.300	.85	.190
	Soy Bean Silage			
1	.26	.027	.09	.013
2	.52	.054	.17	.026
3	.77	.081	.26	.039
4	1.03	.108	.35	.052
5	1.29	.135	.43	.065
6	1.55	.162	.52	.078
7	1.81	.189	.61	.091
8	2.06	.216	.70	.104
9	2.32	.243	.78	.117
10	2.58	.270	.87	.130
	Corn Cannery Refuse			
1	.21	.003	.12	.006
2	.42	.006	.24	.012
3	.63	.009	.36	.018
4	.84	.012	.48	.024
5	1.05	.015	.59	.030
6	1.26	.018	.71	.036
7	1.47	.021	.83	.042
8	1.68	.024	.95	.048
9	1.89	.027	1.07	.054
10	2.10	.030	1.19	.060

TABLE III—Feeding Stuffs—*Continued*

Roots and Tubers									
Carrot					Potato				
Lbs.	Dry Matter	Digestible			Lbs.	Dry Matter	Digestible		
		Pro.	C-H.	Fat			Pro.	C-H.	Fat
1	.11	.008	.08	.002	1	.21	.011	.16	.001
2	.23	.016	.16	.004	2	.42	.022	.31	.002
3	.34	.024	.23	.006	3	.63	.033	.47	.003
4	.46	.032	.31	.008	4	.84	.044	.63	.004
5	.57	.040	.39	.010	5	1.04	.055	.78	.005
6	.68	.048	.47	.012	6	1.25	.066	.94	.006
7	.80	.056	.55	.014	7	1.46	.077	1.10	.007
8	.91	.064	.62	.016	8	1.67	.088	1.26	.008
9	1.03	.072	.70	.018	9	1.88	.099	1.41	.009
10	1.14	.080	.80	.020	10	2.09	.110	1.57	.010
Sugar Beet					Common Beet				
1	.13	.013	.10	.001	1	.11	.012	.08	.001
2	.27	.026	.20	.002	2	.23	.024	.16	.002
3	.40	.039	.29	.003	3	.34	.036	.24	.003
4	.54	.052	.39	.004	4	.46	.048	.32	.004
5	.67	.065	.49	.005	5	.57	.060	.39	.005
6	.81	.078	.59	.006	6	.69	.072	.47	.006
7	.94	.091	.69	.007	7	.80	.084	.55	.007
8	1.08	.104	78	.008	8	.92	.096	.63	.008
9	1.21	.117	.88	.009	9	1.03	.108	.71	.009
10	1.35	.130	.98	.010	10	1.15	.120	.79	.010
Mangel					Rutabaga				
1	.09	.010	.05	.002	1	.11	.010	.08	.002
2	.18	.020	.11	.004	2	.23	.020	.16	.004
3	.27	.030	.16	.006	3	.34	.030	.24	.006
4	.36	.040	.22	.008	4	.46	.040	.32	.008
5	.45	.050	.27	.010	5	.57	.050	.40	.010
6	.55	.060	.33	.012	6	.68	.060	.49	.012
7	.64	.070	.38	.014	7	.80	.070	.57	.014
8	.73	.080	.44	.016	8	.91	.080	.65	.016
9	.82	.090	.49	018	9	1.03	.090	.73	.018
10	.91	.100	.55	.020	10	1.14	.100	.81	.020
Flat Turnip					Wet Beet Pulp				
1	.10	.009	.06	.001	1	.10	.005	.08	.000
2	.20	.018	.13	.002	2	.20	.010	.15	.000
3	.30	.027	.19	.003	3	.31	.015	.23	.000
4	.40	.036	.26	.004	4	.41	.020	.31	.000
5	.49	.045	.32	.005	5	.51	.025	.38	.000
6	.59	.054	.38	.006	6	.61	.030	.46	.000
7	.69	.063	.45	.007	7	.71	.035	.54	.000
8	.79	.072	.51	.008	8	.82	.040	.62	.000
9	.89	.081	.58	.009	9	.92	.045	.69	.000
10	.99	.090	.64	.010	10	1.02	.050	.77	.000

TABLE III—FEEDING STUFFS—*Continued*

CONCENTRATES—*Ground Grains and By-Products*									
Corn					Barley				
Lbs.	Dry Matter	Digestible Pro.	Digestible C-H.	Digestible Fat	Lbs.	Dry Matter	Digestible Pro.	Digestible C-H.	Digestible Fat
1	.89	.079	.67	.043	1	.89	.084	.65	.016
2	1.78	.158	1.33	.086	2	1.78	.168	1.31	.032
3	2.67	.237	2.01	.129	3	2.68	.252	1.96	.048
4	3.56	.316	2.67	.172	4	3.57	.336	2.61	.064
5	4.45	.395	3.33	.215	5	4.46	.420	3.26	.080
6	5.35	.474	4.00	.258	6	5.35	.504	3.92	.096
7	6.24	.553	4.67	.301	7	6.24	.588	4.57	.112
8	7.13	.632	5.34	.344	8	7.14	.672	5.22	.128
9	8.02	.711	6.00	.387	9	8.03	.756	5.88	.144
10	8.91	.790	6.67	.430	10	8.92	.840	6.53	.160
Oats					Wheat				
1	.90	.107	.50	.038	1	.89	.088	.67	.015
2	1.79	.214	1.01	.076	2	1.79	.176	1.35	.030
3	2.69	.321	1.51	.114	3	2.68	.264	2.02	.045
4	3.58	.428	2.01	.152	4	3.58	.352	2.70	.060
5	4.48	.535	2.51	.190	5	4.47	.440	3.37	.075
6	5.38	.642	3.19	.228	6	5.37	.528	4.05	.090
7	6.27	.749	3.52	.266	7	6.26	.616	4.72	.105
8	7.17	.856	4.02	.304	8	7.16	.704	5.40	.120
9	8.06	.963	4.53	.342	9	8.05	.792	6.07	.135
10	8.96	1.070	5.03	.380	10	8.95	.880	6.75	.150
Wheat Bran					Flour Wheat Middlings				
1	.88	.119	.42	.025	1	.90	.17	.54	.041
2	1.76	.238	.84	.050	2	1.80	.34	1.07	.082
3	2.64	.357	1.26	.075	3	2.70	.51	1.61	.123
4	3.52	.476	1.68	.100	4	3.60	.68	2.14	.164
5	4.40	.595	2.10	.125	5	4.50	.84	2.68	.205
6	5.29	.714	2.52	.150	6	5.40	1.01	3.22	.246
7	6.17	.833	2.94	.175	7	6.30	1.18	3.75	.287
8	7.05	.952	3.36	.200	8	7.20	1.35	4.29	.328
9	7.93	1.071	3.78	.225	9	8.40	1.52	4.82	.369
10	8.81	1.190	4.20	.250	10	9.00	1.69	5.36	.410
Wheat Shorts					Red Dog Flour				
1	.89	.130	.46	.045	1	.90	.162	.57	.034
2	1.78	.260	.91	.090	2	1.80	.324	1.14	.068
3	2.66	.390	1 37	.135	3	2.70	.486	1.71	.102
4	3.55	.520	1.83	.180	4	3.60	.658	2.28	.136
5	4.44	.650	2.28	.225	5	4.50	.810	2.85	.170
6	5.33	.780	2.74	.270	6	5.41	.972	3.42	.204
7	6.22	.910	3.20	.315	7	6.31	1.134	3.99	.238
8	7.10	1.040	3.66	.360	8	7.21	1.296	4.56	.272
9	7.99	1.170	4.11	.405	9	8.11	1.458	5.13	.306
10	8.88	1.300	4.57	.450	10	9.01	1.620	5.70	.340

TABLE III—Feeding Stuffs—*Continued*

Concentrates—*Continued*

Emmer (Speltz)					Corn and Cob Meal				
Lbs.	Dry Matter	Digestible			Lbs.	Dry Matter	Digestible		
		Pro.	C-H.	Fat			Pro.	C-H.	Fat
1	.92	.10	.70	.02	1	.85	.044	.60	.029
2	1.84	.20	1.41	.04	2	1.70	.088	1.20	.058
3	2.76	.30	2.11	.06	3	2.55	.132	1.80	.087
4	3.68	.40	2.81	.08	4	3.40	.176	2.40	.116
5	4.60	.50	3.51	.10	5	4.24	.220	3.00	.145
6	5.52	.60	4.22	.12	6	5.09	.264	3.60	.174
7	6.44	.70	4.92	.14	7	5.94	.308	4.20	.203
8	7.36	.80	5.62	.16	8	6.79	.352	4.80	.232
9	8.28	.90	6.33	.18	9	7.64	.396	5.40	.261
10	9.20	1.00	7.03	.20	10	8.49	.440	6.00	.290
	Kaffir Corn					Sorghum Seed			
1	.90	.052	.44	.014	1	.87	.045	.61	.028
2	1.80	.104	.89	.028	2	1.74	.090	1.22	.056
3	2.70	.156	1.33	.042	3	2.62	.135	1.83	.084
4	3.60	.208	1.77	.056	4	3.49	.180	2.44	.112
5	4.50	.260	2.21	.070	5	4.36	.225	3.05	.140
6	5.41	.312	2.66	.084	6	5.23	.270	3.67	.168
7	6.31	.364	3.10	.098	7	6.10	.315	4.28	.196
8	7.21	.416	3.54	.112	8	6.98	.360	4.89	.224
9	8.11	.468	3.99	.126	9	7.85	.405	5.50	.252
10	9.01	.520	4.43	.140	10	8.72	.450	6.11	.280
	Buckwheat Bran					Buckwheat Middlings			
1	.92	.059	.34	.02	1	.87	.227	.37	.061
2	1.84	.118	.68	.04	2	1.74	.454	.75	.122
3	2.75	.177	1.02	.06	3	2.62	.681	1.12	.183
4	3.67	.236	1.36	.08	4	3.49	.908	1.50	.244
5	4.59	.295	1.70	.10	5	4.36	1.135	1.87	.305
6	5.51	.354	2.04	.12	6	5.23	1.362	2.25	.366
7	6.43	.413	2.34	.14	7	6.10	1.589	2.62	.427
8	7.34	.472	2.72	.16	8	6.98	1.816	3.00	.488
9	8.26	.531	3.06	.18	9	7.85	2.043	3.37	.549
10	9.18	.590	3.40	.20	10	8.72	2.270	3.75	.610
	Rye Bran					Rye Middlings			
1	.88	.112	.47	.020	1	.88	.110	.53	.026
2	1.77	.224	.94	.036	2	1.76	.220	1.06	.052
3	2.65	.336	1.40	.054	3	2.65	.330	1.59	.078
4	3.54	.448	1.87	.072	4	3.53	.440	2.12	.104
5	4.42	.560	2.34	.090	5	4.41	.550	2.64	.130

TABLE III—FEEDING STUFFS—*Continued*

CONCENTRATES—*Continued*

Lbs.	Dry Matter	Digestible Pro.	Digestible C-H.	Digestible Fat	Lbs.	Dry Matter	Digestible Pro.	Digestible C-H.	Digestible Fat
	Millet					Hominy Feed			
1	.88	.071	.48	.025	1	.90	.068	.60	.074
2	1.76	.142	.97	.050	2	1.81	.136	1.21	.148
3	2.64	.213	1.45	.075	3	2.71	.204	1.81	.222
4	3.52	.284	1.94	.100	4	3.62	.272	2.42	.296
5	4.39	.355	2.42	.125	5	4.52	.340	3.02	.370
	Corn Oil Meal					Bean Meal			
1	.91	.158	.39	.108	1	.89	.202	.42	.013
2	1.83	.316	.78	.216	2	1.78	.404	.85	.026
3	2.74	.474	1.16	.324	3	2.67	.606	1.27	.039
4	3.66	.632	1.55	.432	4	3.56	.808	1.69	.052
5	4.57	.790	1.94	.540	5	4.45	1.010	2.11	.065
	Cow Pea Meal					Soy Bean Meal			
1	.85	.168	.55	.011	1	.88	.291	.23	.146
2	1.71	.336	1.10	.022	2	1.77	.582	.47	.292
3	2.56	.504	1.65	.033	3	2.65	.873	.70	.438
4	3.42	.672	2.20	.044	4	3.53	1.164	.93	.584
5	4.27	.840	2.74	.055	5	4.41	1.455	1.16	.730
	Gluten Feed					Gluten Meal			
1	.91	.213	.53	.029	1	.90	.297	.42	.061
2	1.82	.426	1.06	.058	2	1.81	.594	.85	.122
3	2.72	.639	1.58	.087	3	2.71	.891	1.27	.183
4	3.63	.852	2.11	.116	4	3.62	1.188	1.70	.244
5	4.54	1.065	2.64	.145	5	4.52	1.485	2.12	.305
	Linseed Meal					Cotton-seed Meal			
1	.90	.302	.32	.069	1	.93	.376	.21	.096
2	1.80	.604	.64	.138	2	1.86	.752	.43	.192
3	2.71	.906	.96	.207	3	2.79	1.128	.64	.288
4	3.61	1.208	1.28	.276	4	3.72	1.504	.86	.384
5	4.51	1.510	1.60	.345	5	4.65	1.880	1.07	.480
	Flax Seed					Tankage			
1	.91	.206	.17	.290	1	.930	.501	.00	.116
2	1.82	.412	.34	.580	2	1.860	1.002	.00	.232
3	2.72	.618	.51	.870	3	2.790	1.503	.00	.348
4	3.63	.824	.68	1.160	4	3.720	2.004	.00	.464
5	4.54	1.030	.85	1.450	5	4.650	2.505	.00	.580

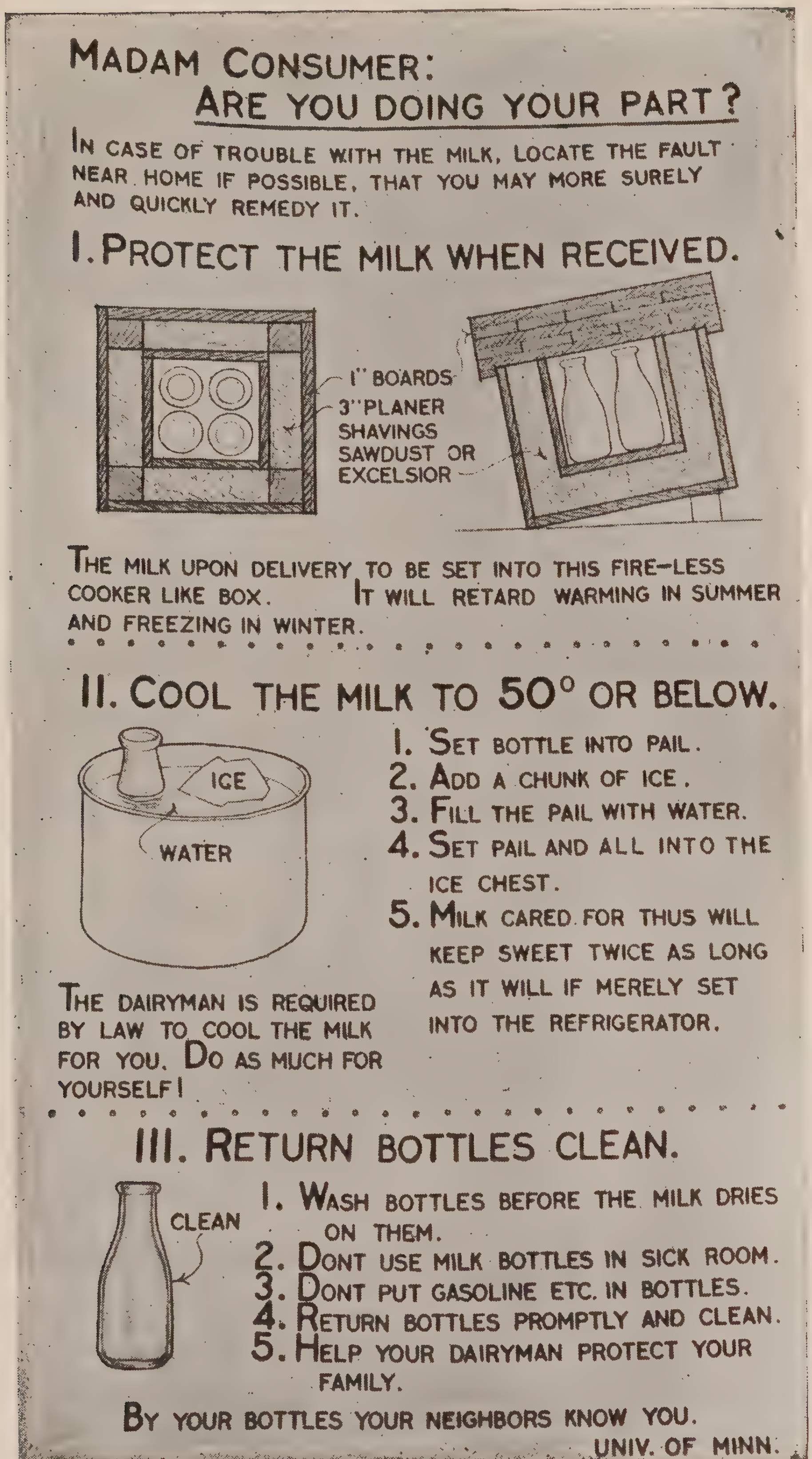

FIG. 131.—Chart used in milk campaigns.

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